

THE AFRICAN SPECIES OF *STIVALIUS*,
A GENUS OF SIPHONAPTERA

BY

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Pp. 39-76 ; 65 *Text-figures*

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THE AFRICAN SPECIES OF *STIVALIUS*, A GENUS OF SIPHONAPTERA

By F. G. A. M. SMIT

THE seven species of the large genus *Stivalius* (Family Pygiopsyllidae) which were hitherto known to occur in Africa¹ are redescribed and figured in the present paper, while six new species of *Stivalius* from Africa are described and also the hitherto unknown male of *S. sellatus*; a key is provided for the identification of these thirteen species.

The specimens examined are in the Rothschild and British Museum collection of fleas at Tring, unless stated otherwise.

The thirteen African species of *Stivalius* belong to two groups which can be distinguished as follows:

- (a) Genal margin below the eye divided into two partly overlapping small lobes (Text-fig. 1); ♂—movable process of clasper without a dense group of thin setae on inner side (Text-fig. 5); tendons of phallosome very short, not or hardly reaching beyond the apex of the aedeagal apodeme (Text-fig. 16); dorsal margin of aedeagal apodeme nearly straight, not deeply concave preapically (Text-fig. 16); ♀—no paired sclerotic structure alongside the bursa copulatrix (Text-fig. 25); dilated part of ductus spermathecae slender, with a number of thick sclerotic internal rings, giving this part of the duct a strong resemblance to a tape-worm (Text-fig. 25)²; bulga of spermatheca with a thin wall and internal striae (Text-fig. 25)
ferinus-group, p. 42
- (b) Genal margin below the eye entire (Text-fig. 2); ♂—movable process of clasper with a dense group of straight and thin setae on inner side and bordering the ventral margin (Text-figs. 8-15); tendons of phallosome making at least half a convolution (Text-fig. 17) and often much more (Text-fig. 18); apical half of dorsal margin of aedeagal apodeme strongly concave (Text-figs. 17, 18); ♀—bursa copulatrix in most species with a dark sclerotic structure on each side (Text-figs. 26, 28-37); the dilated part of the ductus spermathecae with a large number of very thin internal rings (Text-figs. 26, 28-37); bulga of spermatheca with a thick wall and without internal striae (Text-figs. 26, 28-37) *torvus*-group, p. 47

¹ Jordan & Rothschild (1922, *Ectoparasites*, 1: 252, 254) recorded *Stivalius ahalae* and *S. aporus* from Mfongosi, Zululand; these two rat-parasites do not belong to the African fauna, but to that of India and Burma. In all probability this record was due to some error, perhaps mislabelling.

² The ductus spermathecae is similarly ringed in females belonging to the following groups of *Stivalius*: *robinsoni*-group (squirrel-parasites: *S. robinsoni* (Rothschild) (Malaya, Sumatra), *S. javanus* Jordan (Java), *S. rhaebus* Jordan (Borneo) and *S. lonchus* Jordan (Borneo)); *ahalae*-group (rat-parasites: *S. ahalae* (Rothschild) (India), *S. aporus* Jordan & Rothschild (India, Ceylon), *S. phoberus* Jordan & Rothschild (Ceylon) and *S. cognatus* Jordan & Rothschild (Java)); *jacobsoni*-group (rat-parasites: *S. jacobsoni* (Jordan & Rothschild) (Java, Sumatra) and *S. klossi* (Jordan & Rothschild) (Annam, Thailand, Malaya, Sumatra, Java)); squirrel and *Tupaia* parasite *S. mjobergi* Jordan (Borneo).

FERINUS-GROUP

The new species described below is the only known representative of the *ferinus*-group in Africa. Of the other three species, belonging to this group, two occur in the Oriental Region (Ceylon, India, Malaya) and one in Japan.

Stivalius alienus sp. n.

(Text-figs. 1, 3, 5-7, 16, 25)

TYPE MATERIAL. Male holotype, female allotype and 8 male paratypes from Calonne plantation, nr. Elisabethville, Belgian Congo, from a nest (probably of a gerbil), 9. vi. 1953; 1 female paratype from the same locality, from *Rattus (Mastomys) natalensis*, vi. 1953; 2 female paratypes, nr. Elisabethville, from *Rattus (Mastomys) natalensis*, viii. 1953; all collected by Dr. R. Devignat, to whom one pair of paratypes has been returned; 1 male paratype from the neighbourhood of Elisabethville, from *Crocidura pilosa*, 1957; 1 female paratype, same locality, from *Mus triton*, 1957; 1 female paratype, same locality, from *Pelomys fallax*, 1957—these three specimens were collected by P. L. Pirlot and the male and one female are in the Musée Royal du Congo Belge, Tervuren; 1 male paratype from the Suji Valley, 6,000 ft., S. Pare Mts., Tanganyika, i. 1957, from *Arvicanthis* sp., collected by J. G. Halcrow.

DIAGNOSIS. A member of the *ferinus*-group, which includes *S. ferinus* (Rothschild) (a shrew-parasite from Ceylon and India), *S. insolli* Traub (a bird-parasite from Malaya) and *S. aestivalis* Jameson & Sakaguti (a wood-mouse (*Apodemus*) parasite from Japan). The new species differs from *S. ferinus* by the unmodified (not sub-spiniform) setae in the submarginal frontal row, from *S. insolli* and *S. aestivalis* by the absence of a row of short setae preceding the main row of setae on the pronotum, while in *S. insolli* the number of pronotal spines is about 30 as against 20 in *S. alienus*. There are also differences in the genitalia between these species.

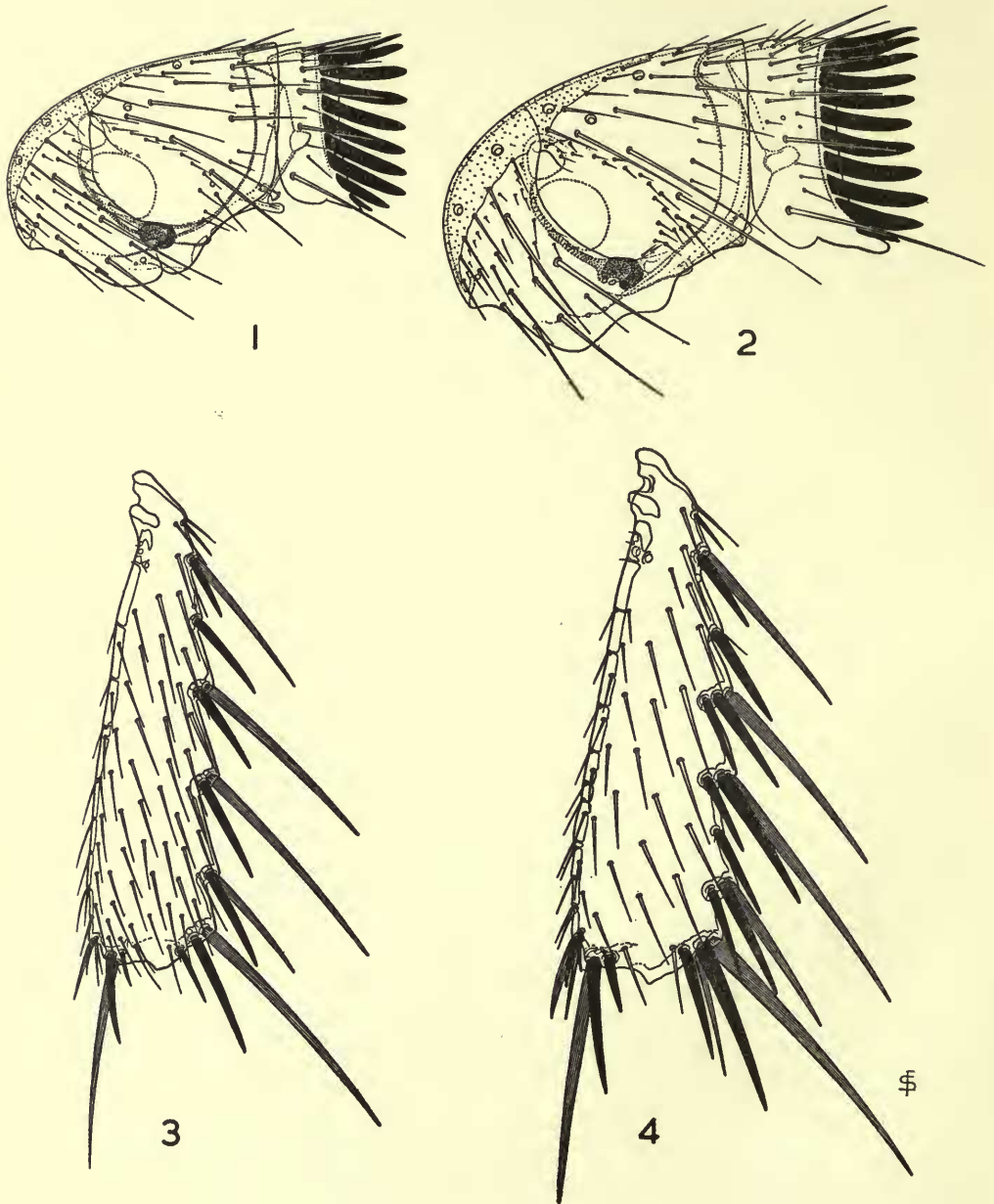
DESCRIPTION. **HEAD** (Text-fig. 1). Frontoclypeal margin smoothly rounded. Preoral tuber short. Submarginal frontal row consisting of six setae in both sexes; between this row and the eye there are about a dozen large and fairly large setae and numerous minute setae on the preantennal region of the head, the minute ones absent on the gena. Genal margin below the eye divided into two short lobes the anterior of which partly overlaps the posterior. Frontal area of micropores relatively narrow. Eye well developed, kidney-shaped. Maxillary palps not quite reaching to the middle of the anterior margin of the fore coxa; the first segment longer than the second, while the third segment is the shortest of the four. The laciniae are smooth basally and extremely finely serrated apically. The labial palp, reaching to about two-thirds the length of the fore coxa, consists of five segments. Scapus of antenna on the outer side of its widened portion with five to six thin setae in the male and three to four in the female; pedicellus in both sexes with six slender setae, several of which reach to or a little beyond the first segment of the clava; the clava consists of the usual nine segments (excluding the petiolus). Postantennal region of head with three rows of setae (the displaced seta between the first and second row in

Text-fig. 1 is an abnormality) and a large seta about mid-way between the lowest seta of the second and third row ; the first row consists of five setae each side in the male and six in the female, while the second row normally has six setae each side in both sexes as has also the third row. Bordering the antennal fossa posteriorly are about 11-14 small setae in both sexes.

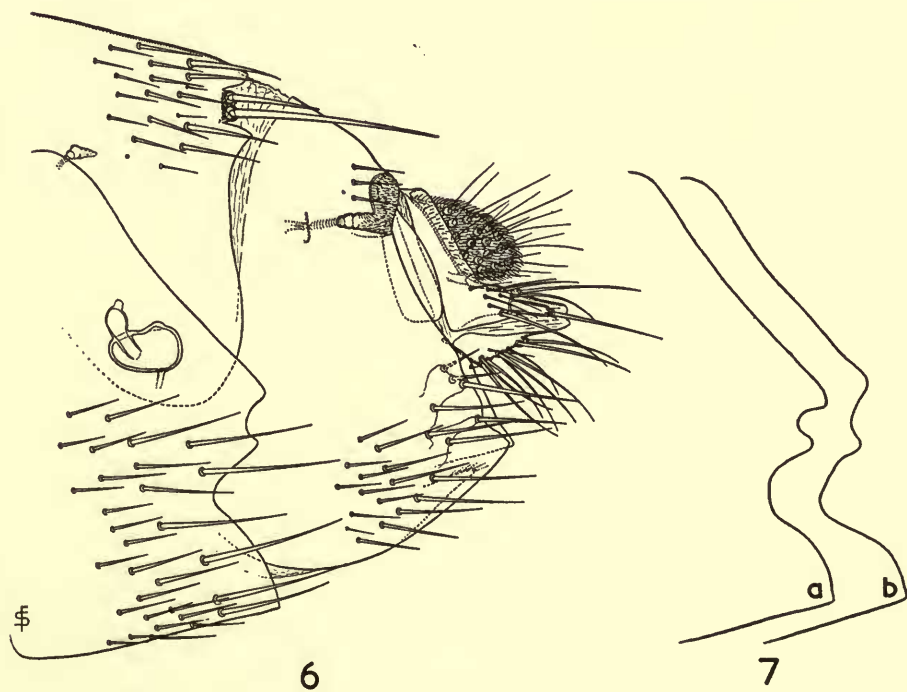
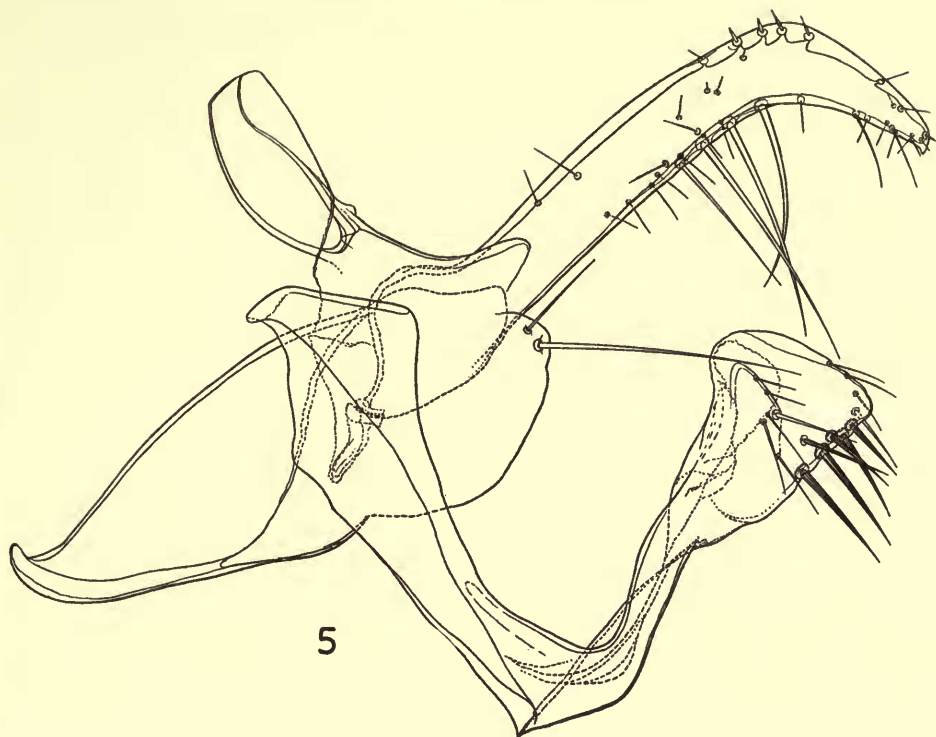
THORAX. Pronotum (Text-fig. 1) narrow, with one row of six setae each side and a ctenidium of 20 slightly curved spines which are longer than the pronotum. Mesonotum with a main row of five setae each side, preceded by two rows of more numerous small and irregularly placed setae ; two fairly long pseudosetae dorsally under the collar of the mesonotum. Mesepisternum with three to four setae, of which one or two are usually small ; mesepimeron normally with six (sometimes seven) setae. Metanotum with three rows of setae ; the first row consists of two to three setae in the male, four to six in the female, the second and third rows in both sexes with seven to ten and six setae respectively (the lowest seta of the main row much smaller than the others in the row) ; in the female the first metanotal row is preceded by one or two small dorsal setae. Pleural arch well-developed. Metepisternum with one large and one or two minute setae ; metasternum dorso-posteriorly with one large seta ; metepimeron with one to three small and eight to nine large setae in the male, three to four small and nine to eleven large setae in the female.

LEGS. Fore coxa with numerous setae all over the outer side ; mid coxa with setae along the lower half of the anterior margin, a patch of setae on the outer side of the ventro-anterior part and two (sometimes three) ventro-posterior setae ; the oblique suture of the outer surface of the mid coxa is uninterrupted ; chaetotaxy of hind coxa similar to that of mid coxa, but in addition there is a small group of short setae ventro-anteriorly on the inner side. Fore femur, apart from marginal setae, with 12-16 lateral setae on the outer side and only one very small seta on the basal part of the inner side. Mid and hind femora with the usual marginal and submarginal setae, but without lateral setae. All tibiae with seven notches in the posterior (dorsal) margin, the most dorsal one bearing only two smallish setae ; chaetotaxy of the hind tibia as shown in Text-fig. 3. Fifth segment of all tarsi with six pairs of lateral plantar setae, arranged as is usual in the genus, namely the first and third pairs shifted on to the plantar surface in the fore and mid tarsus, while in the hind tarsus only the third pair is shifted on to the planta ; in the male the last segment of fore and mid tarsi has four short and stout subapical plantar setae. The two preapical lateral setae are short on the fifth segment of all tarsi, reaching to about the middle of the claws.

ABDOMEN. Tergum I with three distinct rows of setae and a few dorsal setae in front of the first row ; terga II-VII with two distinct rows of setae and in addition several dorsal setae in front of the first row and these may form an irregular short row. The numbers of setae in the main row on each side of terga I-VII are in the male : 4, 7, 7, 7, 7, 7, 7 respectively ; in the female : 4, 7, 8, 8, 8, 7, 4 (or 5). Terga II-V in both sexes each with one marginal spinelet on each side near the dorsum. Both sexes with two antesensilial setae, the lower of which is more than twice the length of the upper ; in the female (Text-fig. 6) the margin of tergum VII between



FIGS. 1, 2. Head and pronotum of: 1. *Stivalius alienus* sp. n. (female paratype, plantation Calonne). 2. *S. torvus* (Rotschild) (female, Kisii, Kenya). Figs. 3, 4. Hind tibia of: 3. *S. alienus* sp. n. (female allotype). 4. *S. torvus* (Rothschild) (female, Keruguya, Kenya).



FIGS. 5-7. *Stivalius alienus* sp. n. 5. Clasper and sternum IX (holotype). 6. Terminalia (allotype). 7. Outline of sternum VII of female (*a*—paratype, nr. Elisabethville, *b*—paratype, plantation Calonne).

the two sets of antesensilials is produced into a short triangular lobe; below the antesensilials the margin forms in the female an angulate lobe and below this the margin is slightly concave for a considerable distance. Basal abdominal sternum with a lateral patch of two to four setae in the male and 13-17 in the female, and with two setae each side along the ventral margin of which one is placed in front of the other. Sterna III-VII in the male normally with three setae each side in the main row, in the female the main row of sterna III-VI consists of four setae; in both sexes these main rows are preceded by a patch of numerous smaller setae.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 5, 16). Tergum VIII with 0-3 setae each side anterior to the vertical part of the spiracular fossa. Sternum VIII with about 30-35 setae each side. Apodeme of tergum IX narrow, ventrally not solidly fused with the dorso-caudal part of the manubrium, the latter basally very broad and tapering gradually to an upturned tip (Text-fig. 5). Fixed process of clasper with two (one short, one long) acetabular setae. Movable process (Text-fig. 5) of a shape characteristic for the majority of the representatives of the genus, with relatively few setae along the ventral (posterior) margin and a group of three large setae and one smaller one placed along this margin just before the bend. Proximal arm of sternum IX (Text-fig. 5) fairly broad; the distal arm of this sternum narrow in its basal half whence it widens gradually, its dorso-apical portion smoothly rounded; four or five of the setae along the apical part of the ventral margin much stouter than the other setae of the apical portion. Phallosome as in Text-fig. 16; note the very short tendons of the phallosome, the straight and simple inner tube, the dorso-apical aedeagal sclerite with two sharp apical projections, and the long and narrow caudally curved and membranous lobe of the ventral lateral wall.

FEMALE (Text-figs. 6, 7, 25). Posterior margin of sternum VII (Text-figs. 6, 7) with a double sinus, the upper bay of which is much smaller than the lower; the main row consists of five strong setae and is divided by a gap between two dorsal setae and three ventral ones. In front of this row are numerous smaller setae. Variation in the outline of the posterior margin of sternum VII as shown in Text-figs. 6, 7. Tergum VIII with three to six setae in front of the widened vertical part of the spiracular fossa; chaetotaxy of the ventral part of tergum VIII as in Text-fig. 6. Sternum VIII apically narrow and with several minute setae at and near the apex. Anal segment as in Text-fig. 6; anal stylet about thrice as long as its maximum width, with one long apical seta and two minute preapical ones. Bulga of spermatheca (Text-figs. 6, 25) longer than wide, with a dorsal hump; the hilla protrudes deeply into the lumen of the bulga and bears apically a papilla. Ductus bursae curved, bursa copulatrix with a longish posterior internal sclerotization. The basal half of the ductus spermathecae is internally reinforced by numerous sclerotic rings (Text-fig. 25).

LENGTH. ♂ $2\frac{1}{2}$ - $2\frac{3}{4}$ mm., ♀ 3 - $3\frac{1}{2}$ mm.

REMARKS. Even without the host records it would have been possible to deduce *Stivalius alienus* to be probably a parasite of rodents. The species of the *ferinus*-group provide an excellent example of the modifications of the pronotal ctenidium which arise in response to the nature of host-relationships. In *S. alienus* (Text-fig. 1)

and in *S. aestivalis* (Text-fig. 63) (a flea of *Apodemus*) the pronotal ctenidium consists of fairly straight spines—this is the usual type of ctenidium in a large number of rodent-fleas. In *S. ferinus* (Text-fig. 64), a parasite of shrews, the spines of the pronotal ctenidium are blunt and distinctly curved and are longer than the pronotum—this is characteristic of a number of shrew-fleas. In *S. insolli* (Text-fig. 65), a bird-parasite, the number of pronotal spines has increased considerably—about 30 as against 18–20 in the three mammal parasites of this group; fleas of the super-family Ceratophylloidea which have become parasites of birds always have a larger number of pronotal spines (usually more than 24) than related forms living on mammals.

TORVUS-GROUP

The members of this group, which is confined to Africa, are rather uniform in the structure of the head, thorax, legs and unmodified abdominal segments; the main differences between the species are in the genitalia. *Stivalius torvus*, by far the commonest and most widespread member of the group, is described in detail, and the other species are described in comparison with this species.

Stivalius torvus (Rothschild), 1908

(Text-figs. 2, 4, 8, 17, 26, 28, 38, 39, 53, 54)

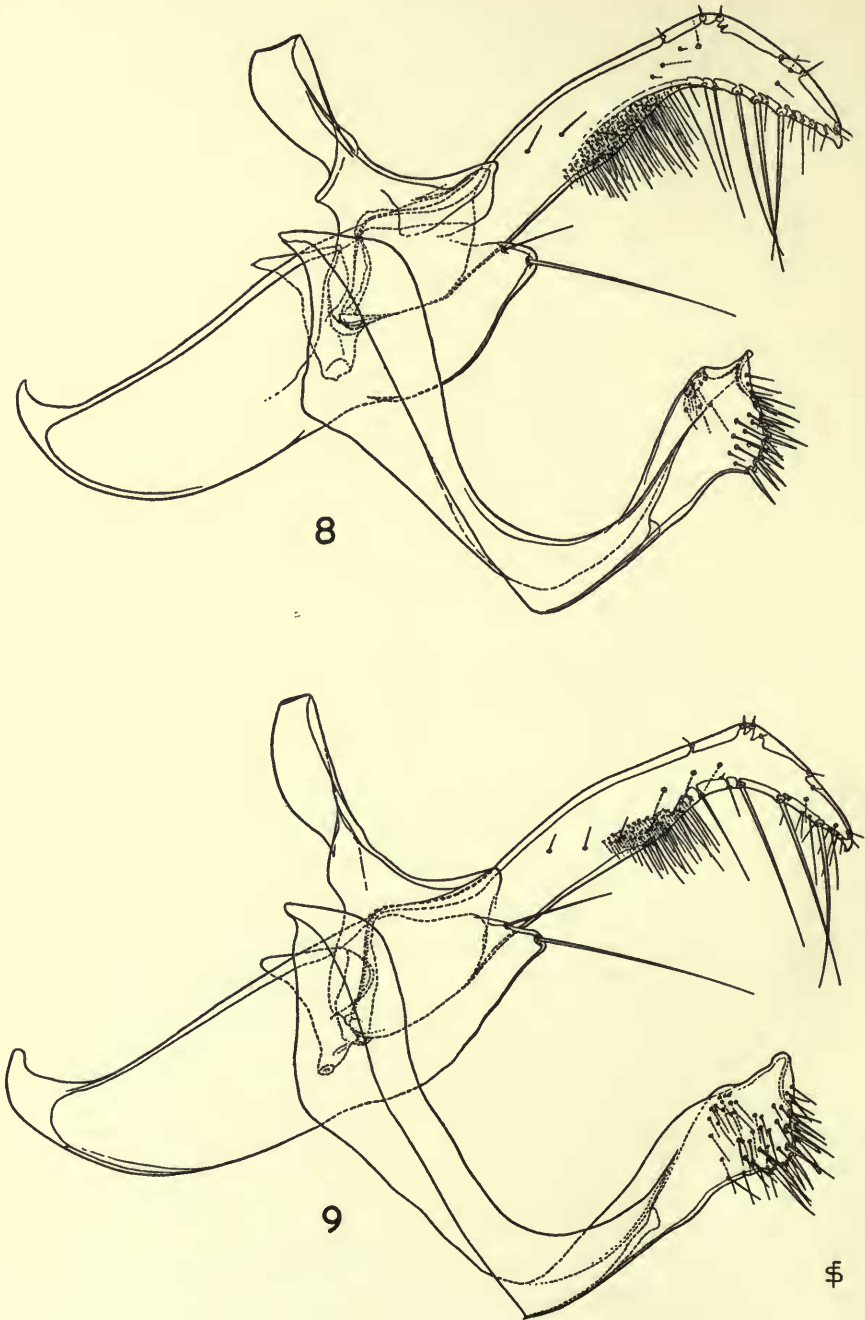
Pygiopsylla torvus Rothschild, 1908, *Ent. mon. Mag.* **44**: 77.

Pygiopsylla "afer" Jordan & Rothschild, 1913, *Novit. zool.* **20**: 537 (err. det., 1 ♀ from Kagamba, Uganda; see Jordan & Rothschild, 1922, *Ectoparasites*, **1**: 252).

Stivalius "afer" Symes & Hopkins, 1932, *Rec. Med. Res. Lab. Nairobi* (**1**): 18, 19, 40, 44, 56.

Stivalius torvus Jordan & Rothschild, 1922, *Ectoparasites*, **1**: 251, 264, fig. 241; Dalla Torre, 1924, *Ber. naturw. med. Ver. Innsbruck*, **39**: 11; Jordan, 1936, *Novit. zool.* **39**: 297, figs. 54–56; Jordan, 1937, *Novit. zool.* **40**: 290; Hopkins, 1947, *Uganda J.* **11** (Suppl.): 155; Jordan, 1948, in Smart, *Insects of medical importance* (London): 240; Hopkins, 1949, *Rep. rats, fleas, plague, Uganda*: 9, tables 2, 6, 10, 12, 20.

MATERIAL EXAMINED. TANGANYIKA: Tengeru, *Rattus (Mastomys) natalensis*, 26.ii.1952, 1 ♂, 1 ♀. KENYA: Keruguya, *Rattus (Mastomys) natalensis*, *Lophuromys flavopunctatus aquilus*, *Lemniscomys* sp., *Otomys* sp., 1935–36, 10 ♂ 8 ♀; without locality and host, 1927, 1 ♀, and 1913, 1 ♂, 3 ♀; Machakos, house-rat, 23.v.1927, 2 ♀ (Jordan, 1936: 297); Kisii, house-rat, 23.v.1927, 1 ♀. UGANDA: Mubuku valley, E. side of Ruwenzori, 6,000 ft. *Grammomys dryas*, 1.iii.1906, the male holotype (Rothschild, 1908: 77; Jordan & Rothschild, 1922: 252); Kanungu, Kigezi, *Lophuromys flavopunctatus aquilus*, 2.x.1940, 1 ♀; same locality, *Arvicanthis abyssinicus*, x.1940, 1 ♀; Kagamba, Kazara county, Ankole, *Dasymys incomtus medius*, 14.vii.1911, 1 ♀ (Jordan & Rothschild, 1913: 537, as "afer"; 1922: 252); Damba Island, Lake Victoria, young rodent in nest, xi.1911, 1 ♀. BELGIAN CONGO (specimens in the Musée Royal du Congo Belge, Tervuren, are marked with (MCB)): Irumu district, Ituri, *Arvicanthis abyssinicus*, 15.viii.1946, 3 ♀ (MCB); Kunga, Mt. Wago, Ituri, nest of *Oenomys hypoxanthus*, 23.vii.1946, 1 ♀ (MCB); Pikanza, Ituri, *Rattus (Mastomys) natalensis ugandae*, 14.v.1946, 1 ♂ (MCB); Blukwa, Ituri, *Rattus (Mastomys) natalensis ugandae*, 13.xii.1945, 1 ♀ (MCB); Blukwa,

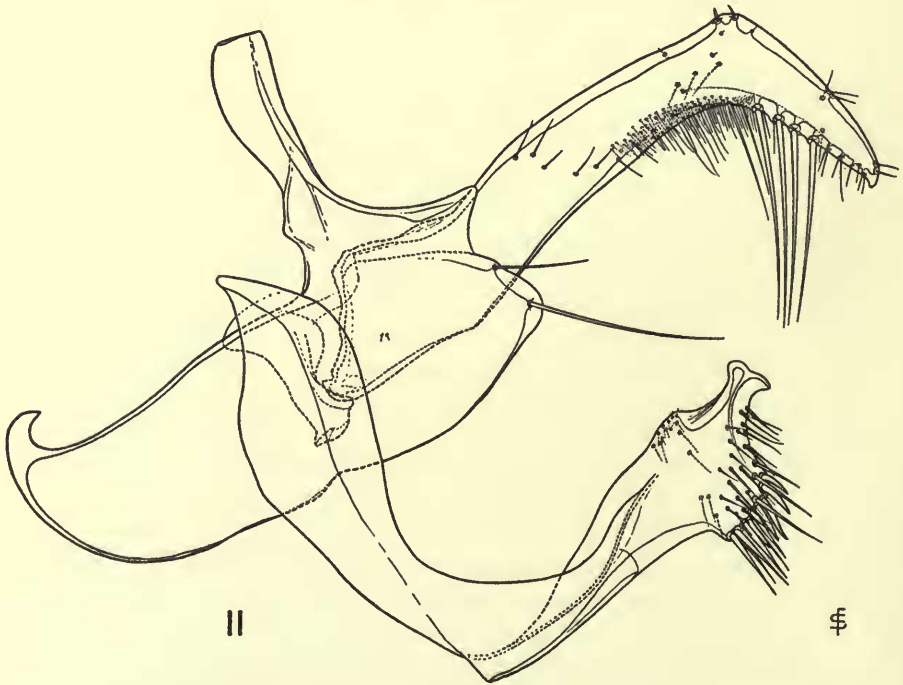
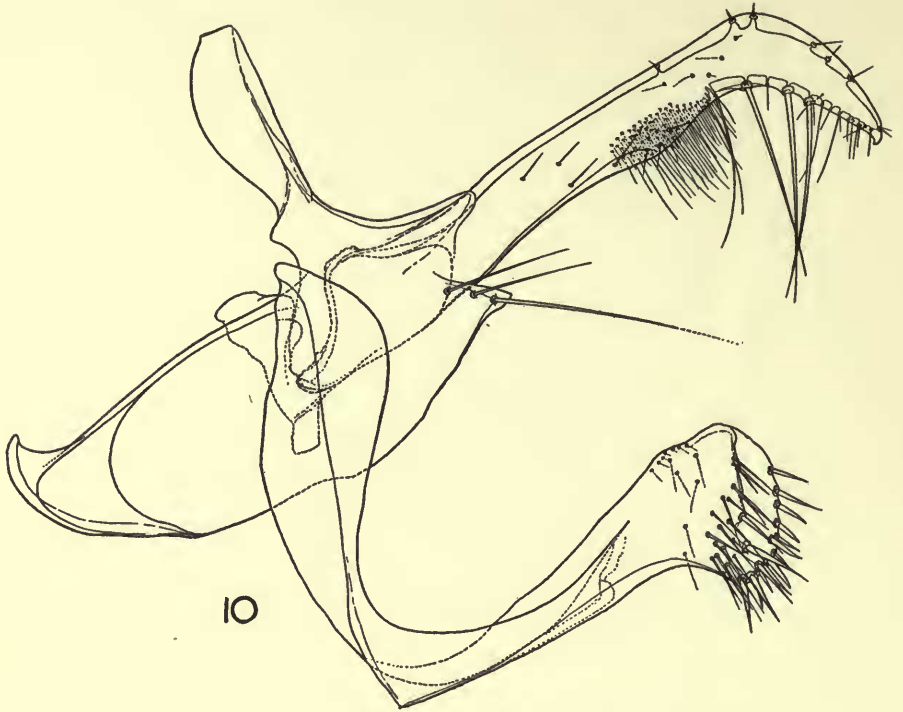


FIGS. 8, 9. Clasper and sternum IX of: 8. *Stivalius torvus* (Rothschild) (Keruguya, Kenya). 9. *S. parilis* sp. n. (holotype).

rats, 1931, 1 ♀ (MCB); Blukwa, 1940, 1 ♀ (MCB); Blukwa, *Rattus (Mastomys) natalensis ugandae*, ii. 1935, 1 ♂; Lombu nr. Blukwa, *Rattus (Mastomys) natalensis ugandae*, 19. xii. 1945, 1 ♀ (MCB); Rakwa nr. Blukwa, *Rattus (Mastomys) natalensis ugandae*, 9. x. 1945, 1 ♂ (MCB); Drodro nr. Blukwa, *Arvicanthis abyssinicus* 2. ix. 1945, 1 ♂ (MCB); Lotomukubwa nr. Blukwa, *Arvicanthis abyssinicus*, 15. x. 1945, 1 ♂ (MCB); Costermansville, Kivu district, rats, 1940, 1 ♂, 1 ♀; Lubero, Kivu, field rats, xii. 1940, 3 ♂, 3 ♀; Lubero, 1950, 2 ♂, 1 ♀; Boyoro region, Geti-Boga, *Rattus (Mastomys) natalensis ugandae*, iv. 1929, 1 ♂, 1 ♀ (and 1 ♂, 1 ♀ MCB); Dilolo, Katanga, *Tatera valida*, *Rattus (Mastomys) natalensis*, 1934, 2 ♂, 2 ♀ (and 1 ♂, MCB) (Jordan, 1936: 297); Lukolela, Tshuapa district, *Crocidura occidentalis*, 1 ♂ (Jordan, 1937: 290); Elisabethville, Katanga, 1935, 1 ♀; the following are all from the neighbourhood of Elisabethville: *Crocidura pilosa*, 1 ♀; *Steatomys pratensis*, 1 ♂; *Saccostomus campestris*, 5 ♂, 2 ♀; *Rattus (Praomys) morio jacksoni*, 2 ♂, 4 ♀; *Tatera valida*, 1 ♀; *Aethomys chrysophilus*, 1 ♀; *Mus triton*, 1 ♀; *Pelomys fallax*, 2 ♀; *Rattus (Mastomys) natalensis ugandae*, 12 ♂, 16 ♀; *Lophuromys flavopunctatus major*, 1 ♂, 2 ♀ (all these specimens were collected by P. L. Pirlot in 1957); nest of *Steatomys pratensis*, x. 1956, 20 ♂, 32 ♀; *Saccostomus campestris*, 12. iv. 1956, 1 ♂; *Rattus (Mastomys) natalensis*, iii. 1956, 1 ♂, iv. 1956, 1 ♀ (these specimens were collected by M. Lips; part of the Pirlot and Lips material has been generously presented by the Tervuren Museum to the British Museum collection of fleas at Tring).

DESCRIPTION. HEAD (Text-fig. 2). Frontoclypeal margin smoothly rounded. Preoral tuber short, though a little longer than in *S. alienus* (Text-fig. 1). Submarginal frontal row consisting of six setae in both sexes; between this row and the eye there are 12-16 large and fairly large setae, while there are many minute setae situated between the frontal row and the next irregular row and also along the anterior margin of the antennal fossa. Genal margin below the eye entire, not divided into two small lobes. Eye well-developed, kidney-shaped. Maxillary palp reaching to about the middle of the anterior margin of the fore coxa; the first two segments of this palp of subequal length, the third segment the shortest. The laciniae are smooth basally and finely serrated apically. The labial palp, reaching to about three-fourths the length of the fore coxa, consists of five segments. Scapus of antenna with six to nine setae on the outer surface of its widened portion in the male and three to four in the female; pedicellus in both sexes with six to nine slender setae, several of which reach to or a little beyond the first segment of the clava. Postantennal region of head with three rows of setae and a large seta about mid-way between the lowest seta of the second row (the latter seta is moved considerably forward) and that of the third row; in both sexes the first occipital row consists of six setae, the second and third rows of six or seven. Bordering the antennal fossa posteriorly are about 16-20 small setae in the male, 20-25 in the female.

THORAX. Pronotum (Text-fig. 2) dorsally about as long as the dorsal spines of the ctenidium, with two rows of setae, the anterior of which does not extend downwards on to the ventral half of the pronotum and consists of five to seven short setae each side, while the main row consists of six setae each side in both sexes. Pronotal ctenidium with 22-24 spines (occasionally 20, 21 or 25). Mesonotum with



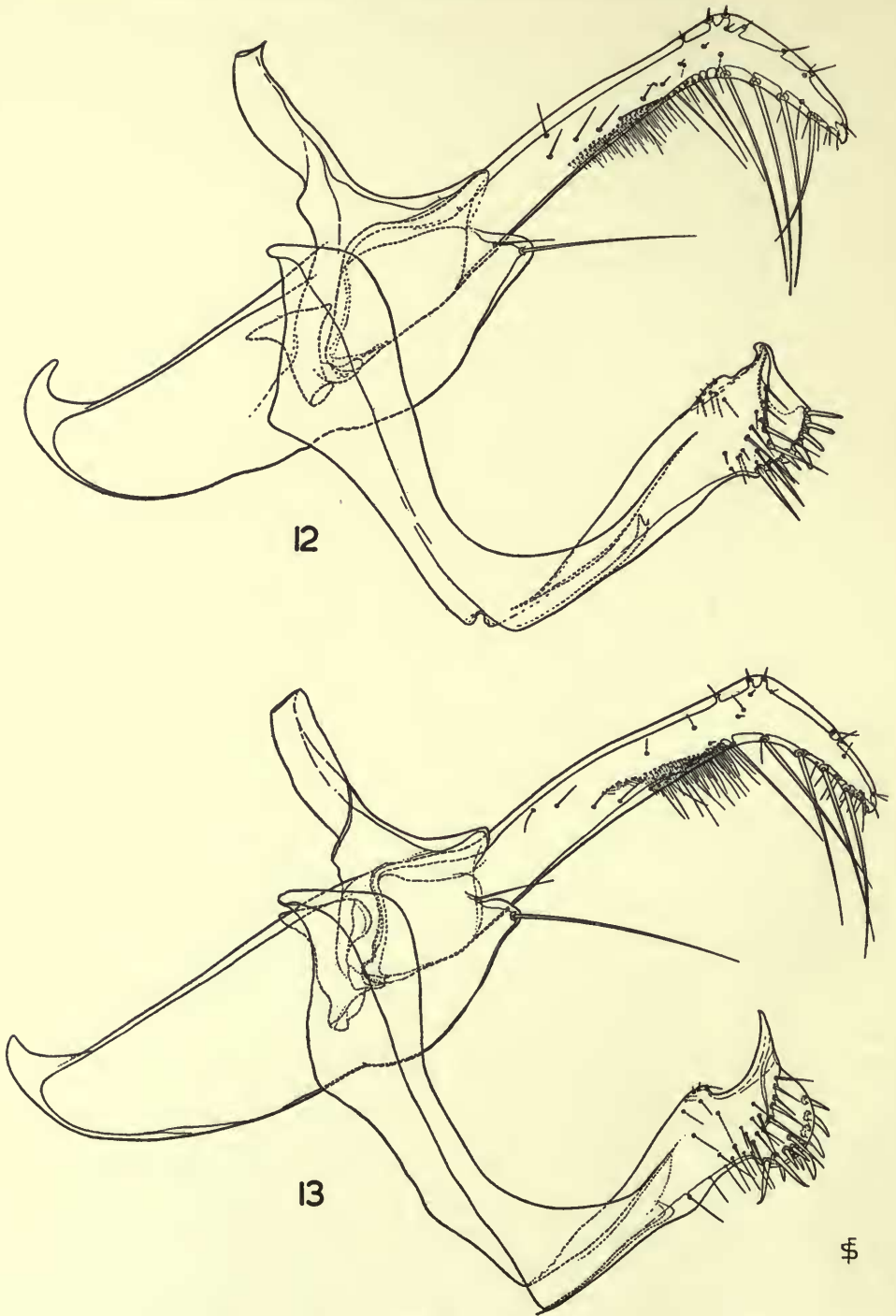
FIGS. 10, 11. Clasper and sternum IX of: 10. *Stivalius timanus* Jordan (holotype). 11. *S. fallaciosus* sp. n. (holotype).

a main row of five setae each side, preceded by three rows of smaller setae; two fairly long pseudosetae present under the dorsal portion of the mesonotal collar. Mesepisternum with three to five small and one large seta, the latter is often placed opposite the internal rod or even beyond this and is then actually on the mesepimeron; mesepimeron with six or seven setae. Metanotum with four rows of setae, the first row being short and irregular; the main row has six setae each side, the lowest of which is the shortest. Pleural arch well developed. Metepisternum with one large and one or two small setae; metasternum dorso-posteriorly with one large and one or two small setae; metepimeron with about five small and nine to ten large setae in the male, five or six small and 11-13 large setae in the female.

LEGS. Chaetotaxy and structure of coxae and femora more or less as in *S. alienus*. Fore tibia with seven groups of setae in notches of the posterior (dorsal) margin, the groups consisting from base to apex of 3, 3, 1, 3, 3, 3 and 3 setae respectively; mid tibia with eight groups: 2, 2, 2, 2, 3, 1 (usually not in a notch), 3 and 3 setae; hind tibia (Text-fig. 4) with eight groups: 2, 2, 1 (or 2), 3, 3, 1, 3 and 3 setae respectively. Fifth segment of all tarsi with the chaetotaxy usual for the genus.

ABDOMEN. Tergum I with four rows of setae; terga II-VII with three rows each, but the first row often very irregular. The numbers of setae in the main row on each side of terga I-VII are in the male 5, 7, 7, 7, 7, 7 and 7 respectively, in the female 5, 7, 8, 8, 8, 7 and 4 (or 5). Terga II-V in both sexes with one subdorsal marginal spinelet each side. Both sexes with two antesensilial setae, the lower of which is about twice the length of the upper; in the female the margin of tergum VII between the two groups of antesensilials forms a triangular lobe; below the antesensilials the margin is angulate. Basal abdominal sternum with a lateral patch of one to five small setae in the male and 12-25 in the female, and along the ventral margin four setae each side forming a horizontal row. Sterna III-VII in the male normally with three large setae on each side in the rather irregular main row; in the female the main row of sterna III-VI consists of three or four setae; in both sexes these main rows are preceded by a patch or numerous smaller setae.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 8, 17). Tergum VIII with four to six setae each side anterior to the vertical part of the spiracular fossa. Sternum VIII with about 30-35 setae each side and a group of three stout and two small closely set setae apically at the ventral margin. Apodeme of tergum IX narrow in its upper part, its lower portion not solidly fused with the corpus of the clasper (Text-fig. 8). Manubrium broad, tapering only weakly, with an upturned apex. Fixed process of clasper with one long and one short acetabular seta. A dark T-shaped sclerite present between the bases of the two manubria. Movable process of the shape which is usual in the genus, long and narrow and with its apical portion turned downwards; with an area of densely set thin and moderately long setae on the inner side bordering the ventral margin, also along this margin, but beyond the bend, are four or five (sometimes only three) long setae. The ventral margin of the movable process gently convex in the setose portion (Text-fig. 8) or practically straight. Distal arm of sternum IX (Text-fig. 8) apically widened, with numerous short setae, many of which are thickened, along the apical margin and unmodified ones on the adjoining lateral portion; dorsally the apical part of the arm bears



FIGS. 12, 13. Clasper and sternum IX of: 12. *Stivalius cacuminis* sp. n. (holotype). 13. *S. richardi* Jordan (holotype).

a patch of very small setae on the inner side. Phallosome as in Text-fig. 17; the tendons of the phallosome make about half a convolution, the inner tube is short and thick-walled and the dorso-apical aedeagal sclerite is of a characteristic shape and structure; the aedeagal apodeme is very broad but preapically the dorsal margin is strongly concave.

FEMALE (Text-figs. 26, 28, 38, 39, 53, 54). Posterior margin of sternum VII with a large sinus, which divides the main row of four or five setae into two upper and two or three lower; in front of this main row are numerous smaller setae (Text-figs. 38, 39). Variation in the outline of the posterior margin of sternum VII is as shown in Text-figs. 38, 39. Tergum VIII with about 8–12 setae in front of the vertical part of the spiracular fossa; chaetotaxy of the ventral part of this tergum as in Text-fig. 53. The posterior margin of tergum VIII has a marked noselike projection, the variation of which is shown in Text-fig. 54. Sternum VIII as in Text-fig. 28. Anal stylet about four to five times as long as its maximum width, with one long apical and two minute preapical setae. Bulga of spermatheca (Text-figs. 26, 28) roughly rectangular, dorsally with a smoothly rounded but rather variable hump; the hilla, bearing a papilla, is much narrower and also shorter than the bulga; both the bulga and the basal half of the hilla have thick or very thick walls. On each side of the bursa copulatrix is a dark and usually triangular (not longitudinal) sclerite (Text-figs. 26, 28). The relatively short dilated part of the ductus spermathecae has a thick wall and is provided internally with numerous membranous rings (Text-fig. 26).

LENGTH. ♂ $2\frac{1}{2}$ – $3\frac{1}{2}$ mm., ♀ 3–4 mm.

Stivalius richardi Jordan, 1936

(Text-figs. 13, 21, 30, 41, 61)

Stivalius richardi Jordan, 1936, *Novit. zool.* 39: 298, figs. 57, 58.

MATERIAL EXAMINED. Male holotype from Dilolo, Katanga, Belgian Congo, from *Malacomys longipes*, 1934; female allotype, same locality and date, from *Steatomys pratensis*. The allotype is in the Musée Royal du Congo Belge at Tervuren.

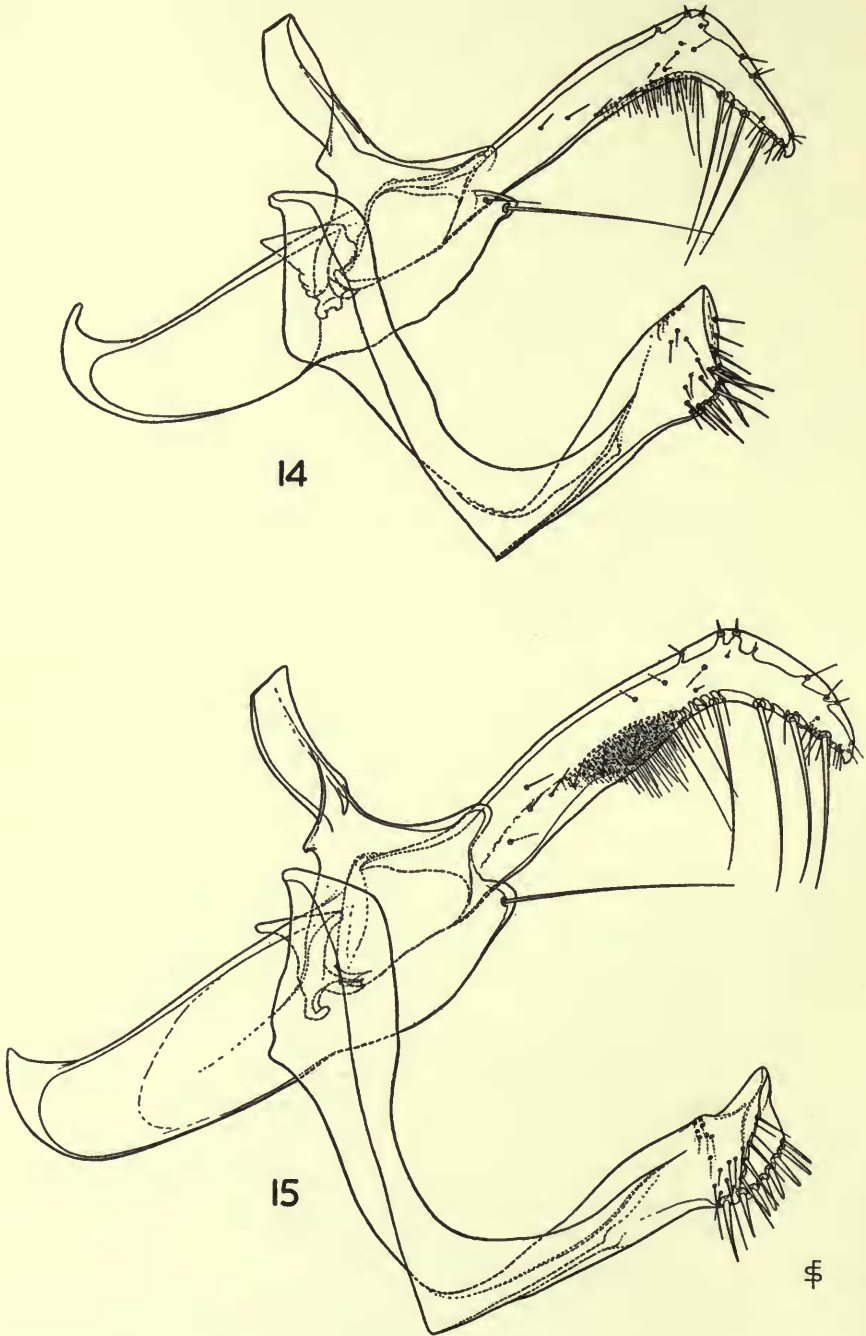
DESCRIPTION. HEAD. Approximately as in *S. torvus*, but the frons is a little more strongly rounded, and there are fewer small setae bordering the antennal fossa dorsally (14–15 in the male, 17–20 in the female).

THORAX. Pronotal ctenidium in both sexes consisting of 24 spines which are somewhat shorter than the pronotum; in other respects the thorax resembles that of *S. torvus*.

LEGS. Fore tibia with seven groups of setae in notches of the posterior (dorsal) margin, the groups consisting from base to apex of 2, 2, 1, 3, 3, 2 and 3 setae respectively; mid tibia with eight groups: 3, 2, 1, 3, 3, 1, 3 and 3 setae; hind tibia with eight groups: 3, 2, 2, 3, 3, 1, 3 and 4 setae.

ABDOMEN. Segments I–VII as in *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 13, 21). Tergum VIII with five to eight setae each side in front of the vertical part of the spiracular fossa. Sternum VIII with about 40 setae each side and the usual ventro-



FIGS. 14, 15. Clasper and sternum IX of: 14. *Stivalius sellatus* Jordan & Rothschild (Torit, Sudan). 15. *S. pivloti* sp. n. (holotype).

marginal group of several short and stout setae. Apodeme of tergum IX as in *S. torvus*; manubrium broad, tapering more distinctly than in *S. torvus*; fixed process of clasper with one short and one long acetabular seta; movable process (Text-fig. 13) almost like that of *S. torvus* but longer and slenderer and the dense group of setae not extending nearly so far away from the margin in *S. richardi*. Apex of distal arm of sternum IX (Text-fig. 13) produced dorsally into a long and sharply pointed spike; chaetotaxy of the distal arm as shown in Text-fig. 13. Aedeagus as in Text-fig. 21; the tendons of the phallosome make about half a convolution, the short inner tube has a very thick dorsal wall and the dorso-apical aedeagal sclerite is very large.

FEMALE (Text-figs. 30, 41, 61). Sternum VII as in Text-fig. 41. The ventral and posterior margins of tergum VIII meet at about a right angle without forming a projection; noselike projection of the posterior margin of tergum VIII rounded-off (Text-fig. 61); chaetotaxy of this tergum approximately as in *S. torvus*. Sternum VIII rather narrow apically (Text-fig. 30). Anal stylet only three and a half times as long as its maximum width. Bulga of spermatheca (Text-fig. 30) thick-walled, almost without a dorsal hump; hilla with a large papilla. The sclerite on each side of the bursa copulatrix is exceptionally large and dark and is shaped like the sole of a shoe, in the only known specimen, covering the short dilated part of the ductus spermathecae almost completely (Text-fig. 30).

LENGTH. ♂ $3\frac{1}{2}$ mm., ♀ 4 mm.

Stivalius curtiductus sp. n.

(Text-figs. 29, 40, 62)

TYPE MATERIAL. Female holotype from Mt. Tonkoni nr. Man, Ivory Coast, 900-1,200 m., 20-30.ix.1946, A. Villiers.

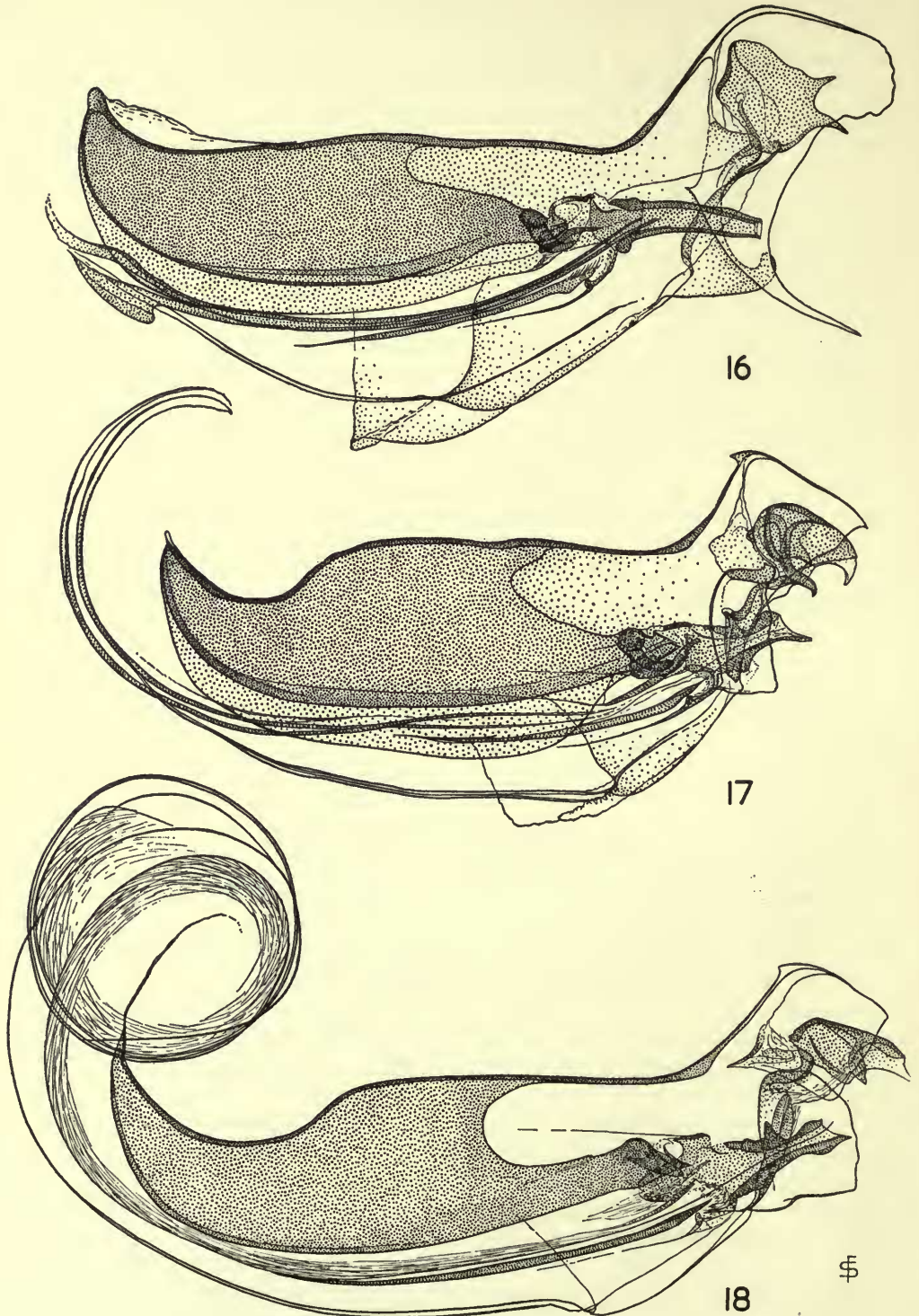
DIAGNOSIS. The female of this new species (the male is unknown) is easily distinguishable from other species of the *torvus*-group by the pronotal spines being much shorter than the pronotum, the far downwards extension of the first row of setae on the pronotum, and the sharp ventro-apical angle of tergum VIII.

DESCRIPTION. HEAD. Eye kidney-shaped, but a little more rounded than in *S. torvus*. The laciniae are somewhat more coarsely serrated than in the latter species, and the serration extends from the tip of the laciniae to about the middle. In other respects the head resembles that of *S. torvus*.

THORAX. Pronotum dorsally considerably longer than the spines of the pronotal ctenidium, with two rows of setae, the first row of eight or nine setae each side extends downwards well below the middle of the pronotum; the second row consists of six setae each side; pronotal ctenidium with 23 spines. Mesothorax and metathorax essentially as in *S. torvus*.

LEGS. The fourth group of setae (counted from the base) of the mid tibia bears three setae (two in *S. torvus*); otherwise the legs are like those of *S. torvus*.

ABDOMEN. Dorsally in front of the three rows of tergal setae are several irregularly



FIGS. 16-18. Phallosome of: 16. *Stivalius alienus* sp. n. (holotype). 17. *S. torvus* (Rothschild) (Keruguya, Kenya). 18. *S. timanus* Jordan (holotype).

placed setae, while the first two rows are also rather irregular. Tergum VI with eight setae in the main row each side (seven in *S. torvus*). The upper of the two antesensorial setae is about half the length of the lower on one side of the specimen and slightly more than half on the other. Basal abdominal sternum with a lateral patch of about 25 setae each side; the main row on sterna III–VI consists of four or five setae. In other respects the unmodified abdominal segments are like those of *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. FEMALE (Text-figs. 29, 40, 62). Posterior margin of sternum VII (Text-fig. 40) with a rather deep sinus, the lobe above it is obtuse. Tergum VIII with 12 or 13 setae in front of the spiracular fossa. Noselike projection of the posterior margin of tergum VIII weakly developed; the ventro-apical angle of this tergum very sharp (Text-fig. 62). Sternum VIII as in Text-fig. 29. Anal stylet nearly five times as long as its maximum width, with two minute preapical setae and a fairly long apical seta. Bulga of spermatheca with a fairly thick wall, and a small dorsal hump; the sclerite on each side of the very small bursa copulatrix is almost undeveloped (Text-fig. 29). The dilated basal portion of the ductus spermathecae is broad and short and resembles that of *S. torvus*, but it has a thin wall; the remainder of this duct is also very short (Text-fig. 29).

LENGTH. ♀ 4 mm.

Stivalius vancanneyti Berteaux, 1947

(Text-figs. 31, 42, 55)

Stivalius vancanneyti Berteaux, 1947, *Rev. Zool. Bot. Afr.* 40: 105, fig. 9.

MATERIAL EXAMINED. Female holotype, Djugu, Ituri, Belgian Congo, from *Heliosciurus ruwenzori*, collected by R. van Canneyt. The holotype is in the Musée Royal du Congo Belge, Tervuren.

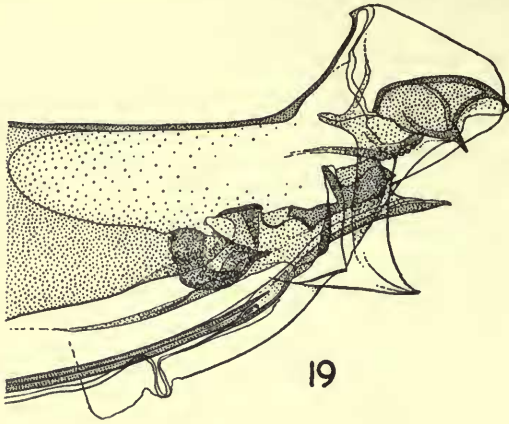
DESCRIPTION. HEAD. Frons rather strongly rounded; chaetotaxy of head similar to that of *S. torvus*. The five-segmented labial palp reaches to the apex of the fore coxa.

THORAX. Pronotum dorsally one and a third longer than the dorsal spines of the pronotal ctenidium; with two rows of setae, the main row consisting of five setae each side. Pronotal ctenidium consisting of 22 spines. In other respects the thorax is similar to that of *S. torvus*.

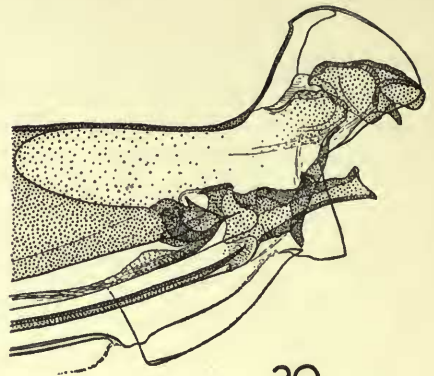
LEGS. Chaetotaxy approximately as in *S. torvus*; in the fourth notch from the base of the hind tibia the anterior of the three setae is displaced downward on both sides of the specimen, but this is possibly abnormal.

ABDOMEN. Unmodified segments as in *S. torvus*.

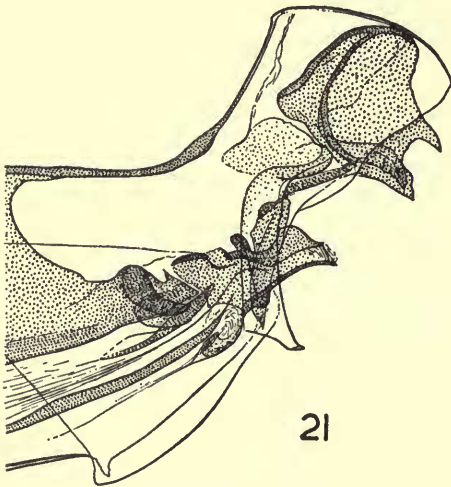
MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. FEMALE (Text-figs. 31, 42, 55). Sternum VII as in Text-fig. 42. A patch of ten setae each side anterior to the spiracular fossa of tergum VIII; ventro-posterior angle of tergum VIII (Text-fig.



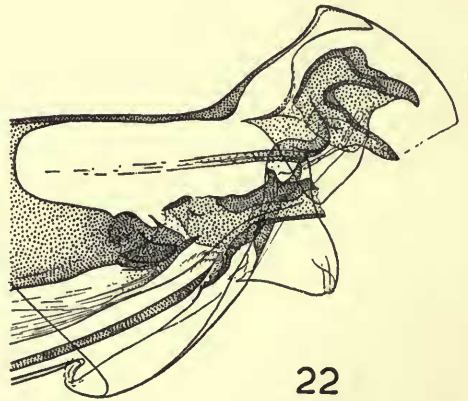
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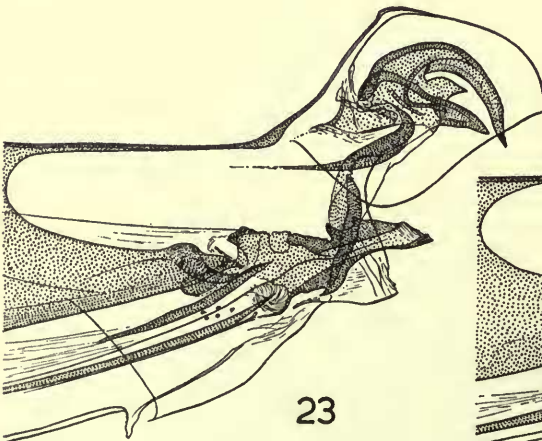
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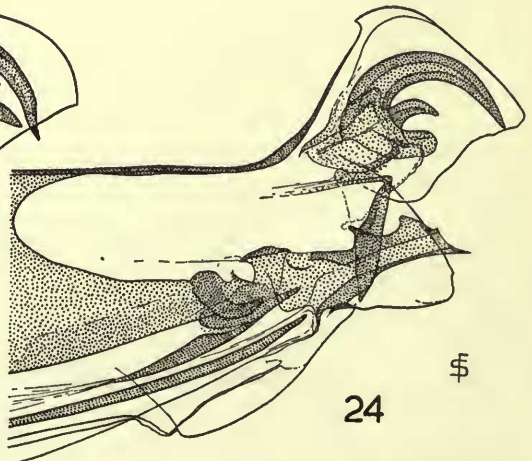
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24

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FIGS. 19-24. Aedeagus of: 19. *Stivalius parilis* sp. n. (holotype). 20. *S. sellatus* Jordan & Rothschild (Torit, Sudan). 21. *S. richardi* Jordan (holotype). 22. *S. fallaciosus* sp. n. (holotype). 23. *S. pirloti* sp. n. (holotype). 24. *S. cacuminis* sp. n. (holotype).

55) rounded off, not forming a projection; posterior margin of tergum VIII with a well-developed noselike projection. Sternum VIII as in Text-fig. 31. Anal stylet about four times as long as basally broad. Genitalia as in Text-fig. 31; the dilated portion of the ductus spermathecae as wide as in *S. torvus*, *richardi* and *curtiductus* but more than twice as long as in any of these three species. Spermatheca so unfavourably placed that its characteristics cannot be made out satisfactorily.

LENGTH. ♀ $4\frac{1}{2}$ mm.

Stivalius afer (Rothschild), 1908

(Text-figs. 32, 43, 56)

Pygiopsylla afer Rothschild, 1908, *Proc. zool. Soc. Lond.* (1908): 618, Pl. 29, figs. 7, 8.

Stivalius afer Jordan & Rothschild, 1922, *Ectoparasites*, 1: 250, 264, fig. 240 (*partim*; the description and figure of the male pertain to the next new species); Dalla Torre, 1924, *Ber. naturw. med. Ver. Innsbruck*, 39: 11; Bedford, 1932, *Rep. Vet. Res. S. Afr.* 18: 449 (*partim*); Jordan, 1936, *Novit. zool.* 40: 93 (*partim*); Jordan, 1948, in Smart, *Insects of medical importance* (London): 240.

Stivalius afer afer Jordan, 1938, *Novit. zool.* 41: 115, 116.

MATERIAL EXAMINED. Female holotype from Benguela Province, Angola, 200 miles from the coast, 4,780 ft., host not known, F. C. Wellman.

DESCRIPTION. HEAD. As in *S. torvus*, but in the only known specimen the eye is oval, not kidney-shaped.

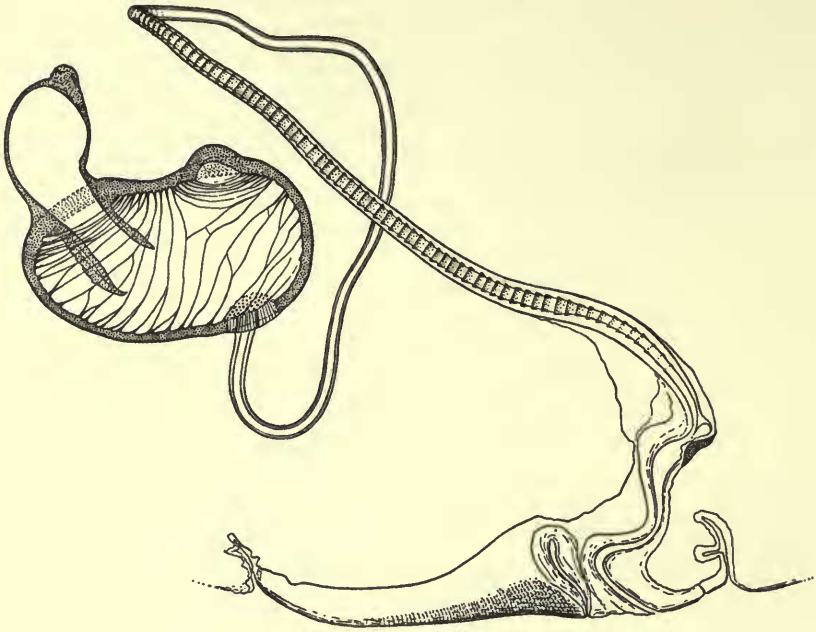
THORAX. As in *S. torvus*; pronotal ctenidium consisting of 24 spines; metepimeron on one side with 11 small and 11 larger setae, on the other with nine small and 12 larger setae.

LEGS. Essentially as in *S. torvus*, but on the dorsal margin of the mid tibia the fourth notch from the base has three setae instead of two and the single seta of the sixth group is marginal.

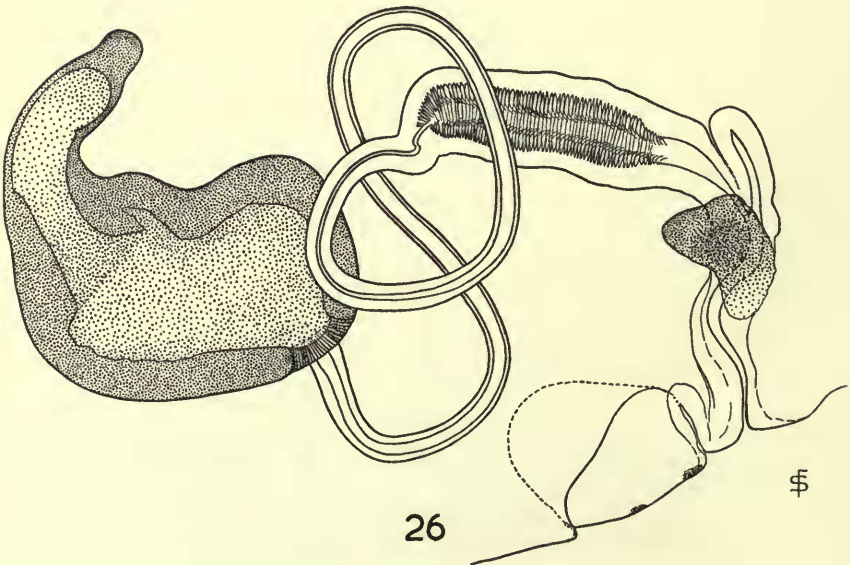
ABDOMEN. Terga II–VII with four rows of setae, but the first row is represented by only a few dorsal setae; in other respects the unmodified abdominal segments are like those of *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. FEMALE (Text-figs. 32, 43, 56). Sternum VII as in Text-fig. 43. The noselike angle of the posterior margin of tergum VIII (Text-fig. 56) is less marked than in *S. torvus*. Apex of sternum VIII with several fairly long setae (Text-fig. 32). Dorsal margin of the bulga of the spermatheca without a definite hump but with a concavity defining an ill-marked postero-dorsal rounded bulge; the base of the hilla protruding slightly into the lumen of the bulga (Text-fig. 32). The sclerite on each side of the bursa copulatrix is long and narrow, much longer than the bursa. The dilated portion of the ductus spermathecae long and relatively narrow, with a thin wall (Text-fig. 32).

LENGTH. ♀ $3\frac{3}{4}$ mm.



25



26

Figs. 25, 26. Female genitalia of: 25. *Stivalius alienus* sp. n. (paratype, nr. Elisabethville)
26. *S. torvus* (Rothschild) (Keruguya, Kenya).

Stivalius parilis sp. n.

(Text-figs. 9, 19, 33, 44, 57)

Stivalius "*afer*" Jordan & Rothschild, 1922, *Ectoparasites*, 1: 250, 264, fig. 240 (*partim*; specimens from N'Dala Tando, Angola); Bedford, 1932, *Rep. Vet. Res. S. Afr.* 18: 449 (*partim*); Jordan, 1936, *Novit. zool.* 40: 93 (*partim*).

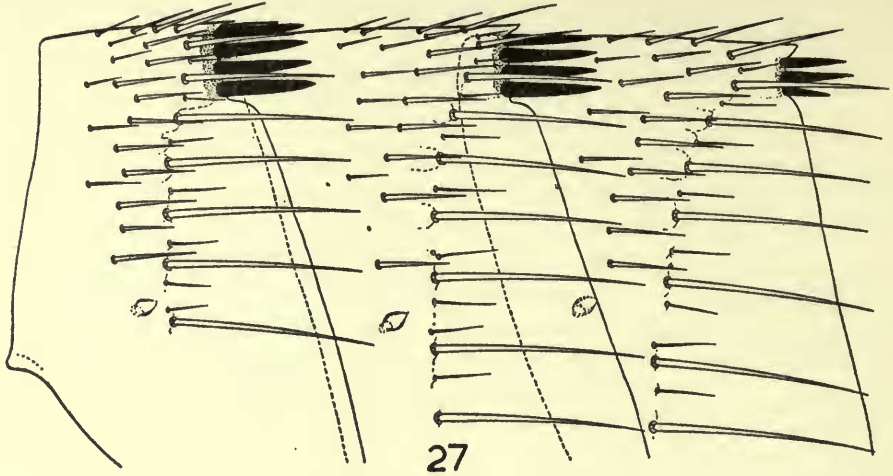
TYPE MATERIAL. Male holotype, female allotype, one male paratype and one female paratype from N'Dala Tando (also spelt Dalla Tando or Dala Tando), Loanda, Angola, from *Arvicanthus niloticus rufinus*, 18.xii.1908, W. J. Ansorge.

DIAGNOSIS. Nearest related to *Stivalius afer* and differing from it in the female sex (the male of *S. afer* is unknown) especially by the fact that the bursa copulatrix is as large as the sclerites associated with it. Some other apparent differences are mentioned in the description.

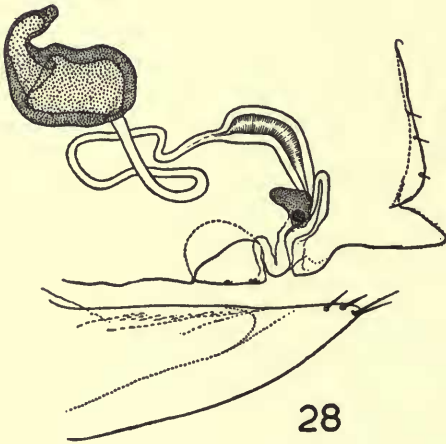
DESCRIPTION. Head, thorax, legs and unmodified abdominal segments as in *S. afer*, except that the eye is kidney-shaped instead of oval, the single seta of the sixth group of the mid tibia is not marginal and the dorso-marginal spinelets of tergum V are small or absent. The pronotal ctenidium consists of 24 spines in both sexes, as in the only known specimen of *S. afer*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 9, 19). Tergum VIII with four or five setae each side anterior to the vertical part of the spiracular fossa. Sternum VIII with about 31-36 setae each side and a group of three stout and several smaller ventro-apical setae. Apodeme of tergum IX very narrow in its dorsal portion, its lower portion not solidly fused with the rest of the clasper (Text-fig. 9). Manubrium fairly broad, feebly tapering, with an upturned apex. Fixed process of clasper with one long and one short acetabular seta. The long straight part of the movable process is slightly convex dorsally and ventrally, with a dense patch of thin setae on the inner surface along the posterior part of the straight ventral margin; the ventral margin of the turned-down tip bears three or four long setae, the most distant of which is not far from the apex. Apex of distal arm of sternum IX only slightly widened, with a bluntly triangular dorso-apical angle and a number of lateral and marginal setae (Text-fig. 9). Aedeagus as in Text-fig. 19; dorsal wall of inner tube extremely thick; ventro-lateral projection of the outer wall of the aedeagus with an acute ventro-posterior angle; aedeagal apodeme broad but the dorsal margin strongly concave pre-apically, the apex produced into a tendril-like structure; the tendons of the phallosome form several convolutions.

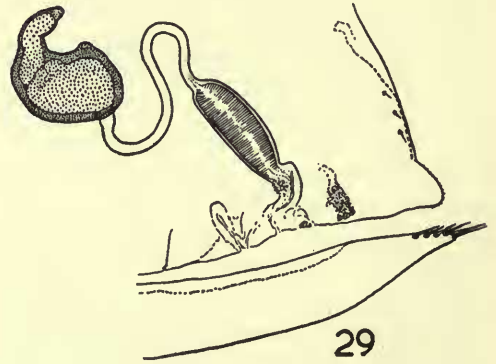
FEMALE (Text-figs. 33, 44, 57). Posterior margin of sternum VII (Text-fig. 44) with a large sinus, which divides the main row of six setae into two groups, each of three setae, in front of this main row are numerous smaller setae. Tergum VIII with about six to eight setae in front of the vertical part of the spiracular fossa; chaetotaxy of the lower part of tergum VIII similar to that of related species. Noselike angle of the posterior margin of tergum VIII rounded off (Text-fig. 57). Sternum VIII as in Text-fig. 33. Anal stylet with a long apical seta and only one minute preapical seta at the dorsal margin. Bulga of spermatheca (Text-fig. 33) rather long, with a relatively thin wall and without a marked dorsal hump; hilla with a papilla.



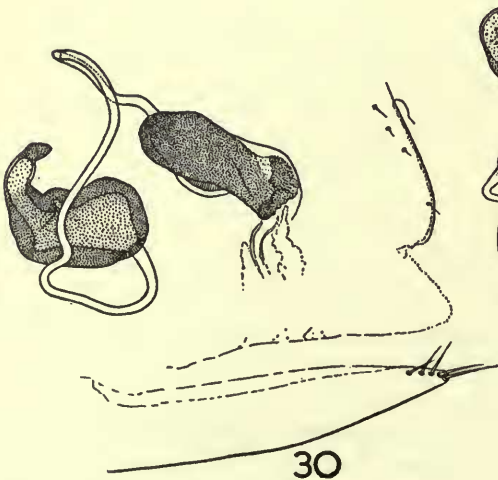
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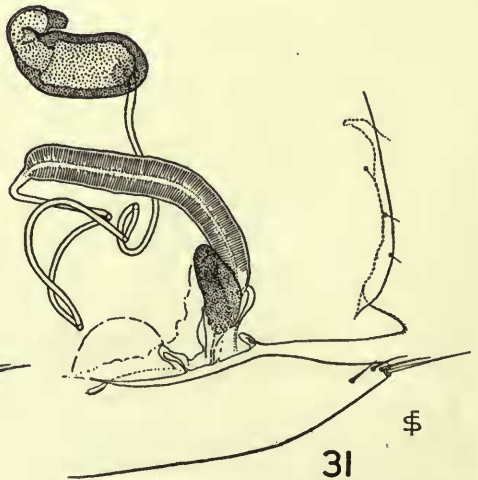
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♀

FIG. 27. *Stivalius pirloti* sp. n. (allotype), terga II-IV. Figs. 28-31. Sternum VIII and IX and genitalia of: 28. *S. torvus* (Rothschild) (Keruguya, Kenya). 29. *S. curti-ductus* sp. n. (holotype). 30. *S. richardi* Jordan (allotype). 31. *S. vancanneyti* Bertheaux (holotype).

The sclerite on each side of the bursa copulatrix is roughly ellipsoid and about as large as the bursa ; the dilated part of the ductus spermathecae is long and narrow and has fairly thick walls.

LENGTH. ♂ $3\frac{1}{2}$ mm., ♀ $3\frac{1}{2}$ –4 mm.

Stivalius timanus Jordan, 1938

(Text-figs. 10, 18, 34, 45, 46, 58)

Stivalius afer timanus Jordan, 1938, *Novit. zool.* 41 : 115, figs. 60, 61.

MATERIAL EXAMINED. From Georgewater Spur¹, Freetown, Sierra Leone : male holotype from *Rattus (Praomys) morio tullbergi*¹, 27.ii.1937, female allotype from the same host species, 1.iii.1937, one female paratype from *Lophuromys sikapusi*¹, 25.ii.1937 ; all collected by D. H. S. Davis.

DESCRIPTION. HEAD. Frons more strongly rounded than in related species. In other respects the head resembles that of *S. torvus*.

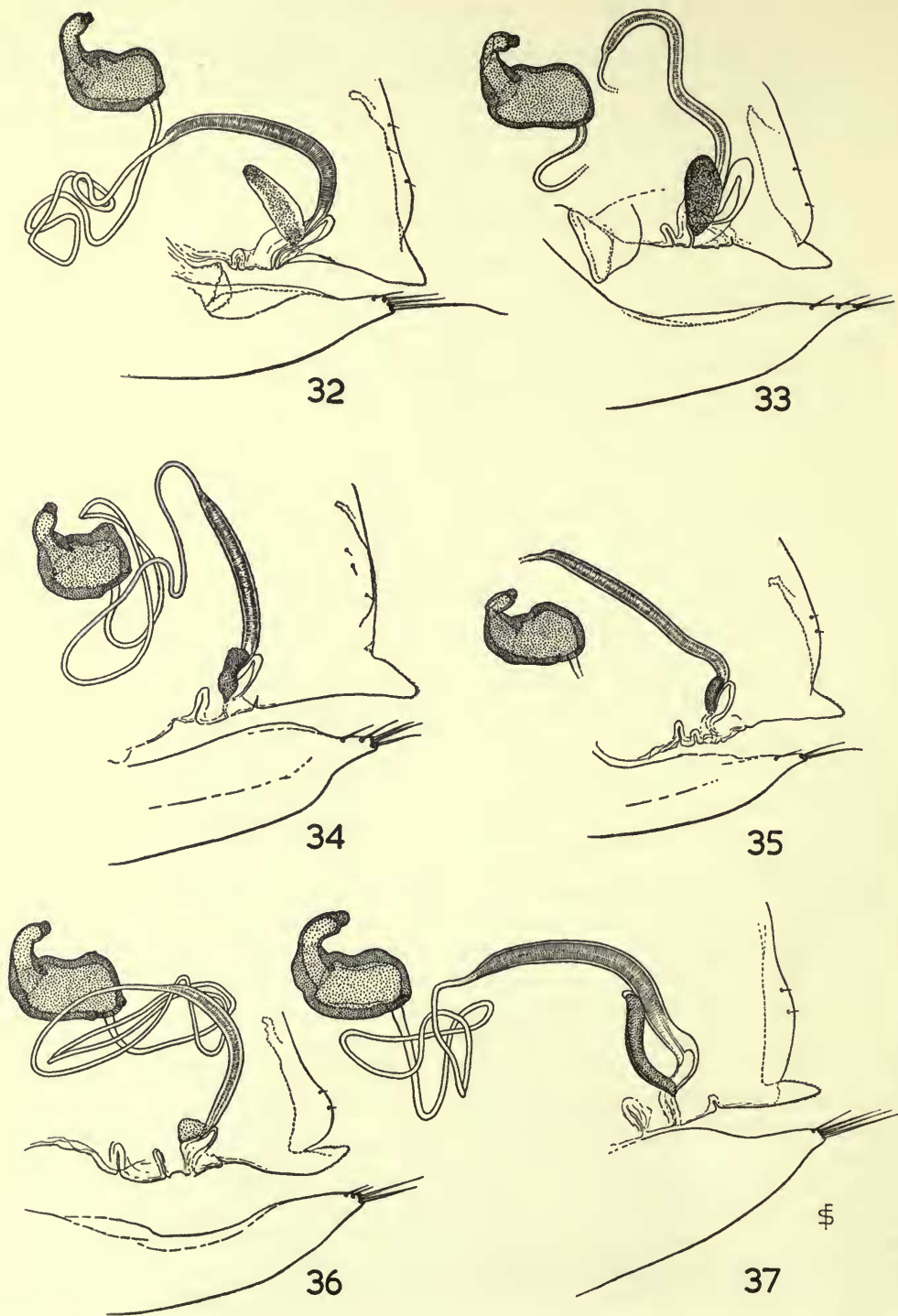
THORAX. Pronotal ctenidium with 23 spines in the male holotype, 24 in the two available females ; the dorsal spines are a little shorter than the dorsal length of the pronotum. The lower of the two pseudosetae each side under the collar of the mesonotum is separated by a clear gap from the upper.

LEGS AND UNMODIFIED ABDOMINAL SEGMENTS. As in *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 10, 18). Tergum VIII of holotype with three setae on one side, four on the other ; sternum VIII with 31 setae on one side, 36 on the other, and the usual group of four to seven short setae apically along the ventral margin. Apodeme of tergum IX as in related species. Manubrium broad, with an upturned tip. Three acetabular setae on one side, two on the other (the latter is doubtless the normal number). Movable process (Text-fig. 10) long and slender, with a straight dorsal margin and a smoothly undulating ventral margin ; with a dense patch of longish thin setae on the inner side adjacent to the convex part of the ventral margin ; the ventral margin of the turned-down apical portion with three long setae, the most apical of which is well away from the apex. Distal arm of sternum IX (Text-fig. 10) ventro-apically strongly widened without a dorso-apical projection, with a number of short setae several of which are spiniform. Phallosome as in Text-fig. 18 ; the tendons of the phallosome make two convolutions ; the aedeagal inner tube has a relatively thin dorsal wall ; the dorso-apical sclerite is rather small ; the aedeagal apodeme is broad, the apical half of its dorsal margin is strongly concave, and its tip is drawn out into a long tendril-like structure.

FEMALE (Text-figs. 34, 45, 46, 58). Sternum VII with the sinus almost as in related species, but the lobe above the sinus relatively long ; variation in the outline of the posterior margin of sternum VII as in Text-figs. 45, 46. Tergum VIII with five to seven setae in front of the vertical portion of the spiracular fossa. Noselike angle of the posterior margin of tergum VIII distinct (Text-fig. 58), but less so than in *S. torvus*. Sternum VIII rather broad, narrowing abruptly a little before the apex

¹ The names of the exact locality and of the hosts, as well as the dates of capture, were not available for the original description, but recently Dr. D. H. S. Davis has kindly supplied these additional data.



FIGS. 32-37. Sternum VIII and IX and genitalia of: 32, *Stivalius afer* (Rothschild) (holotype). 33, *S. parilis* sp. n. (allotype). 34, *S. timanus* Jordan (allotype). 35, *S. nigeriensis* Jordan (holotype). 36, *S. sellatus* Jordan & Rothschild (holotype). 37, *S. pirloti* sp. n. (allotype).

(Text-fig. 34). Anal stylet four or five times as long as wide, with the usual long apical seta but only one preapical minute seta. Bulga of spermatheca (Text-fig. 34) short, very thick-walled, posteriorly with a very prominent hump. The sclerite on each side of the bursa copulatrix is small and somewhat constricted in its middle; it is as long as the small bursa copulatrix (Text-fig. 34). The ductus spermathecae very long, but the dilated portion of the duct (Text-fig. 34) of moderate length, not unlike that of *S. vancanneyti* but relatively much narrower.

LENGTH. ♂ $3\frac{1}{2}$ mm., ♀ $4-4\frac{1}{4}$ mm.

Stivalius nigeriensis Jordan, 1938

(Text-figs. 35, 47, 48, 59)

Stivalius afer nigeriensis Jordan, 1938, *Novit. zool.* 41: 116, fig. 62.

MATERIAL EXAMINED. Female holotype from Lagos, Nigeria, from a bush rat, S. L. M. Counal; one female from Adiopodoumé, Ivory Coast, from *Crocidura* sp., 17.iv.1953, V. Aellen.

DESCRIPTION. HEAD. Essentially as in *S. torvus*, but there are only about 15 small setae bordering the antennal fossa posteriorly.

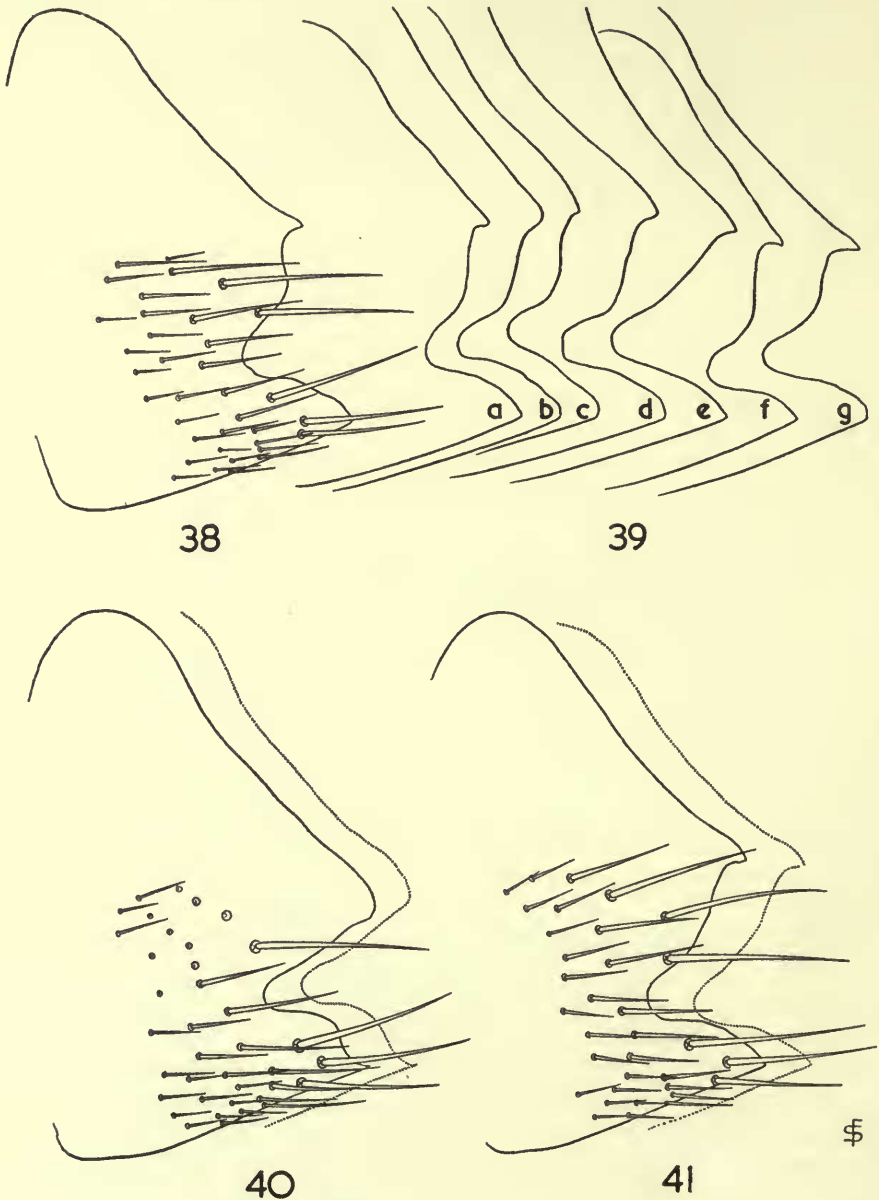
THORAX. Pronotum narrow, dorsally much shorter than the length of the dorsal spines of the pronotal ctenidium, the latter consisting of 20 slightly curved spines. Though narrow, the pronotum still bears two rows of setae (contrast pronotum of *S. alienus*, Text-fig. 1). In other respects the thorax resembles that of *S. torvus*.

LEGS. The tibiae differ from those of all other species of the *torvus*-group by having seven groups of setae in notches of the posterior margin on all the legs, whereas in the other species the fore tibia has seven but the mid and hind tibiae have eight. The numbers of setae in these notches are: mid tibia 2, 2, 2, 2, 3, 2 and 3, hind tibia 2, 2, 1, 2, 2 (or 3), 3, and 3 (the hind tibia closely resembles that of *S. alienus* (Text-fig. 3)).

ABDOMEN. Unmodified abdominal segments as in *S. torvus*, but the upper antensilial seta is a little less than half the length of the lower.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. FEMALE (Text-figs. 35, 47, 48, 59). Sternum VII (Text-figs. 47, 48) of the type usual in the *torvus*-group, the lobe above the sinus only weakly developed. Variation in outline of the posterior margin of sternum VII as shown in Text-figs. 47, 48. Tergum VIII with four to seven small setae in front of the vertical part of the spiracular fossa; noselike projection of the posterior margin of tergum VIII nearly absent, indicated by a weak convexity of the margin (Text-fig. 59). Sternum VIII as in Text-fig. 35. Anal stylet about four times as long as its maximum width, with one or two minute preapical setae and a long apical seta. Bulga of spermatheca (Text-fig. 35) with a convex dorsal margin but without a hump. The sclerite on each side of the bursa copulatrix is small and elongate, kidney-shaped, and as long as the bursa; dilated part of ductus spermathecae rather long and straight (Text-fig. 35).

LENGTH. ♀ $2\frac{3}{4}-3$ mm.



FIGS. 38, 39. *Stivalius torvus* (Rothschild). 38. Sternum VII of female (Tengeru, Tanganyika). 39. Outlines of sternum VII of females (*a*—Kenya, *b*—Keruguya, Kenya, *c*—Kenya, *d*—Lubero, Kivu district, Belgian Congo, *e*—Kanungu, Kigezi, Uganda, *f*—Machakos, Kenya, *g*—Damba Island, Lake Victoria). FIGS. 40, 41. Sternum VII of left hand side and outline (stippled) of right hand side of same sternum. 40. *S. curtiductus* sp. n. (holotype). 41. *S. richardi* Jordan (allotype).

REMARKS. Jordan described *S. nigeriensis* as a subspecies of *S. afer* but remarked that it may represent a separate species since it agrees neither with *torvus* nor with *afer*; he placed it provisionally as a subspecies of *afer* because the sclerite on each side of the bursa copulatrix is more like that of *afer* than that of *torvus*. But the considerable differences in the pronotum, pronotal ctenidium and tibiae between *S. afer* and *S. nigeriensis* show that the latter is better placed as a separate species.

***Stivalius fallaciosus* sp. n.**

(Text-figs. 11, 22)

"*Pygiopsylla torvus*" Jordan & Rothschild, 1911, *Novit. zool.* 18: 71; Jordan & Rothschild, 1922, *Ectoparasites*, 1: 252.

TYPE MATERIAL. Male holotype from Bamenda, Cameroons, S.E. Nigeria, vi. 1909, leg. Adametz, without host-record. The holotype, formerly in the collection of the Zoologisches Museum der Humboldt-Universität in Berlin, has been generously presented by Prof. Dr. F. Peus to the British Museum collection of fleas at Tring.

DIAGNOSIS. The male of this new species can be distinguished from that of related species by the fact that the dense group of thin setae along the ventral margin of the movable process of the clasper extends along the rounded angle of the margin, by the shape of the expanded apical part of the distal arm of sternum IX and by the structure of the aedeagus. Female unknown.

DESCRIPTION. HEAD. Submarginal frontal row consisting of seven setae each side; in other respects the head resembles that of *S. torvus*.

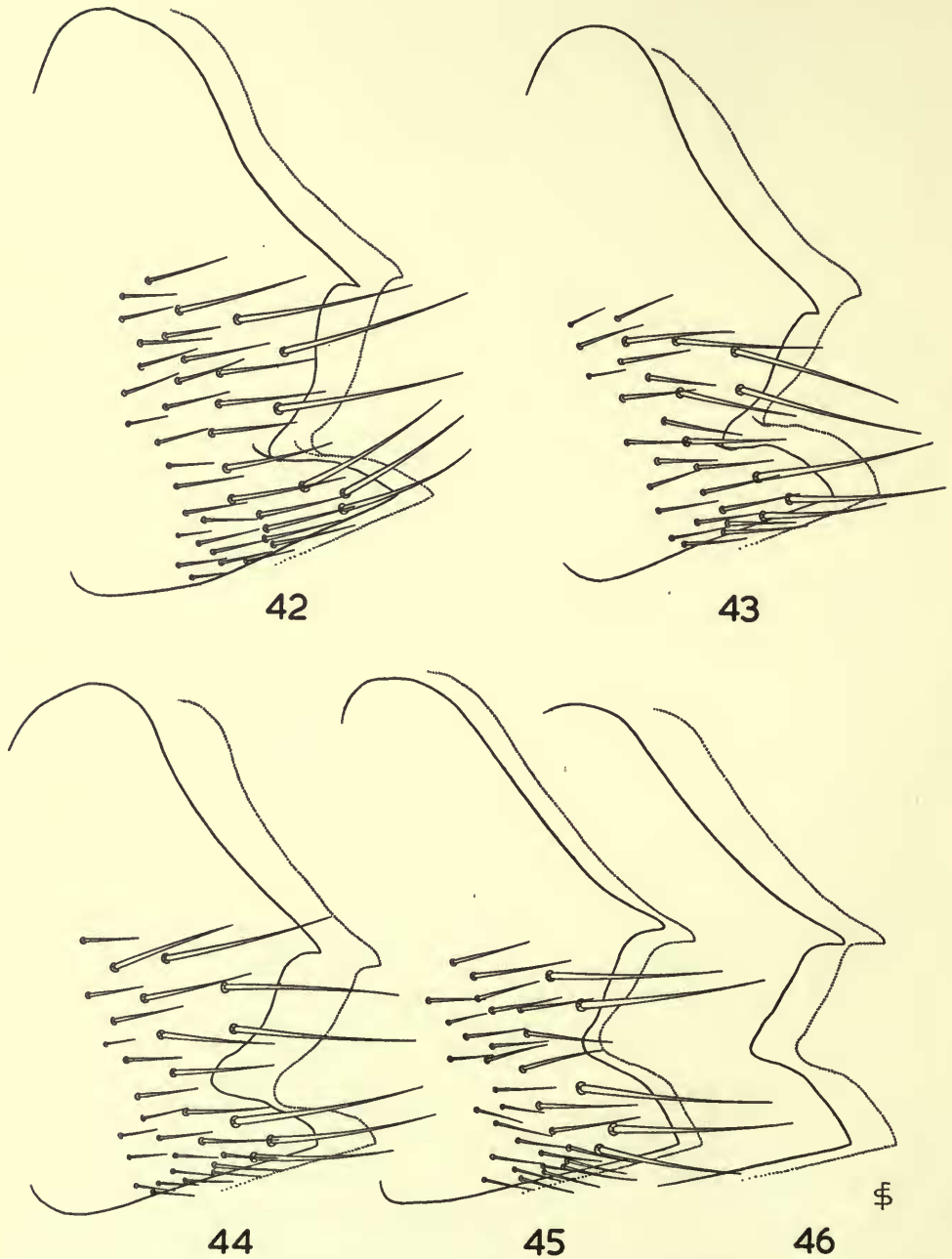
THORAX. Pronotal ctenidium consisting of 23 spines. The two dorsal pseudosetae on each side under the collar of the mesonotum are clearly separated by a gap (as in *S. timanus*).

LEGS. Mid tibia with seven notches in the posterior margin, bearing 2, 2, 1, 2, 3, 2 (or 3) and 3 setae respectively. Otherwise the thorax and legs are essentially as in *S. torvus*.

ABDOMEN. Basal abdominal sternum with one or two small setae anterodorsally; sterna III-VII with a main row of four setae each side. In other respects the unmodified abdominal segments agree with those of *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 11, 22). Tergum VIII with eight setae each side in front of the vertical portion of the spiracular fossa. Sternum VIII with about 40 setae each side and the usual apical ventro-marginal group of several short setae. Apodeme of tergum IX as in *S. torvus*; manubrium broad; fixed process of clasper with one long and one short acetabular seta; movable process short for this group, the four or five long seta at the ventral margin of the bent-down apical portion are placed rather close together (Text-fig. 11). The apex of the distal arm of sternum IX with a characteristic widening, the dorsal projection rather long and its apex splayed out; the ventral spiniform setae form a dense group (Text-fig. 11). Aedeagus as in Text-fig. 22; the tendons of the phallosome make about two convolutions.

LENGTH. ♂ $3\frac{1}{4}$ mm.



FIGS. 42-46. Sternum VII of left hand side and outline (stippled) of right hand side of same sternum. 42. *Stivalius vancanneyti* Berteaux (holotype). 43. *S. afer* (Rothschild) (holotype). 44. *S. parilis* sp. n. (paratype). 45, 46. *S. timanus* Jordan (45—allotype, 46—paratype).

Stivalius sellatus Jordan & Rothschild, 1923

(Text-figs. 14, 20, 36, 49, 60)

Stivalius sellatus Jordan & Rothschild, 1923, *Ectoparasites*, 1: 304, fig. 301; Hopkins, 1947, *Uganda J.* (Suppl.) 11: 155.

MATERIAL EXAMINED. Female holotype from Bubungi, North Bugishu, Eastern Uganda, 28.i.1922, from a rat, W. N. van Someren; one male from Torit, Equatoria, Sudan, 3,800 ft., from a mouse, 7.iv.1950, H. Hoogstraal, presented by Lt.-Col. R. Traub.

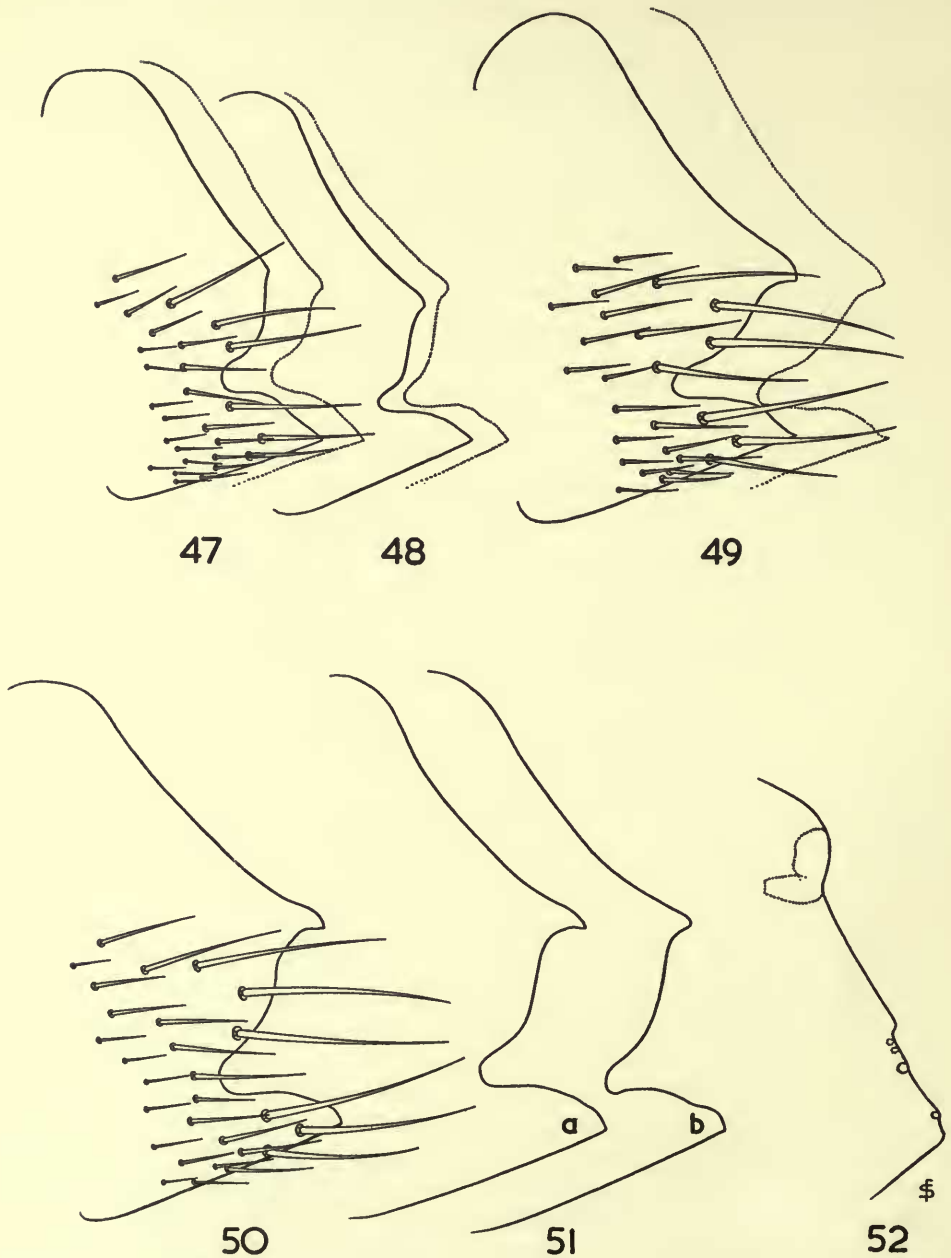
DESCRIPTION. HEAD. Essentially as that of *S. torvus*, but the frons is somewhat more strongly rounded, and the small setae bordering the antennal fossa are less numerous.

THORAX. Like that of *S. torvus*; the pronotal ctenidium with 24 spines in both the available specimens.

LEGS. The outer side of the fore tibia with only three to five lateral setae in the male, six or seven in the female. In both the specimens examined one hind tibia has the usual eight groups of setae in notches along the posterior (dorsal) margin, but on the other side there are nine, an extra single stout seta being present between the second and third notches (counting from the base).

ABDOMEN. Marginal spinelets of terga II-IV developed into moderately large spines which form dorsal ctenidia consisting of six spines each side on all three terga in the male, while in the female there are six and seven on the two sides of terga II and III and six on each side of tergum IV; no spines or spinelets on other terga. Dorsally the ctenidia of each side do not quite meet, but are separated by a short dorsal interspace. Basal abdominal sternum with only one lateral seta in the only male examined, but about 25 in the female holotype. In other respects the chaetotaxy of the unmodified abdominal segments resembles that of *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 14, 20). Tergum VIII anterior to the vertical part of the spiracular fossa with three short setae on one side and four on the other. Sternum VIII with about 25 setae each side and a ventro-marginal group of two stout and three small setae. Apodeme of tergum IX (Text-fig. 14) narrow and of the same construction as in other species of the *torvus*-group. Manubrium much narrower than the width of the basal half of the aedeagal apodeme, rather short, its ventral margin wholly convex. Fixed process of clasper with one very long and slender and one very short acetabular seta. The down-bent apical portion of the movable process bears ventrally two or three long setae and forms about a right angle with the long and straight part of the process, the usual dense patch of thin setae along the ventral margin before the bend is very narrow (Text-fig. 14). Dorsal margin of the widened apical part of the distal arm of sternum IX (Text-fig. 14) smoothly convex, without irregularities in its outline; a group of short setae, several of which are stout but none definitely spiniform, is present at the ventro-apical angle of the apex; the dorso-apical angle is sharp. Aedeagus as in Text-fig. 20; the tendons of the phallosome form about two convolutions; aedeagal apodeme with the deep concavity in the dorso-apical half which is characteristic of the *torvus*-group.



FIGS. 47-49. Sternum VII of left hand side and outline (stippled) of right hand side of same sternum. 47, 48. *Stivalius nigriensis* Jordan (47—holotype, 48—Adiopodoumé, Ivory Coast). 49. *S. sellatus* Jordan & Rothschild (holotype). Figs. 50-52. *S. piriloti* sp. n. 50. Sternum VII of female (allotype). 51. Outlines of sternum VII of two paratypes (nr. Elisabethville) 52. Outline of tergum VIII of female (allotype).

FEMALE (Text-figs. 36, 49, 60). Sternum VII (Text-fig. 49) with a deep sinus of the usual shape dividing the main row of four setae into two groups of two; chaetotaxy of this sternum as shown in the figure. Tergum VIII with eight or nine setae in front of the vertical part of the spiracular fossa; noselike projection of the posterior margin of this tergum rather weakly developed (Text-fig. 60). Sternum VIII as in Text-fig. 36. Anal stylet just over thrice as long as its maximum width, with a long apical seta and two minute preapical setae. Bulga of spermatheca (Text-fig. 36) with a fairly thick wall and a small dorsal hump. The sclerite each side of the extremely small bursa copulatrix is poorly sclerotised and small. The dilated part of the ductus spermathecae is not very long, in contrast with the remainder of this duct (Text-fig. 36).

LENGTH. ♂ 3 mm., ♀ 3 mm.

Stivalius pirloti sp. n.

(Text-figs. 15, 23, 27, 37, 50-52)

TYPE MATERIAL. From the neighbourhood of Elisabethville, Katanga, Belgian Congo, collected by Dr. P. L. Pirlot: male holotype, nine male and three female paratypes from *Rattus (Praomys) morio jacksoni*, 1957; female allotype from Kikusue near Elisabethville, from *Rattus (Praomys) morio jacksoni*, vi. 1956, collected by M. Lips; one female paratype from Kanienge near Elisabethville, from *Rattus (Praomys) morio jacksoni*, vi. 1956, M. Lips. Holotype, allotype and several paratypes in the Musée Royal du Congo Belge, Tervuren.

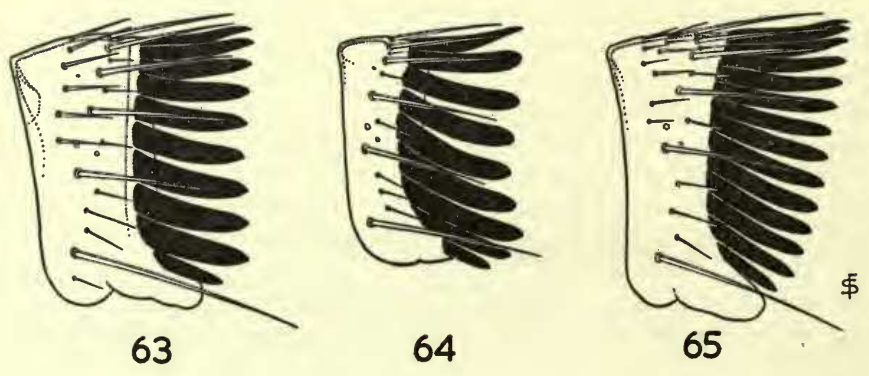
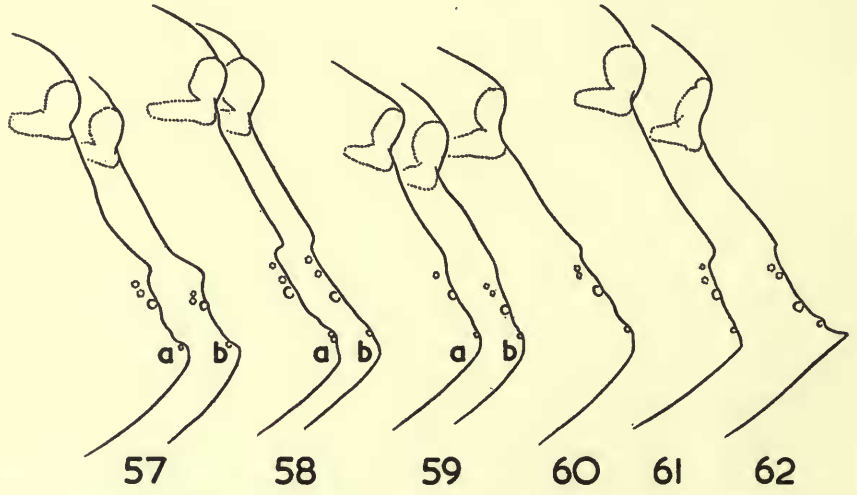
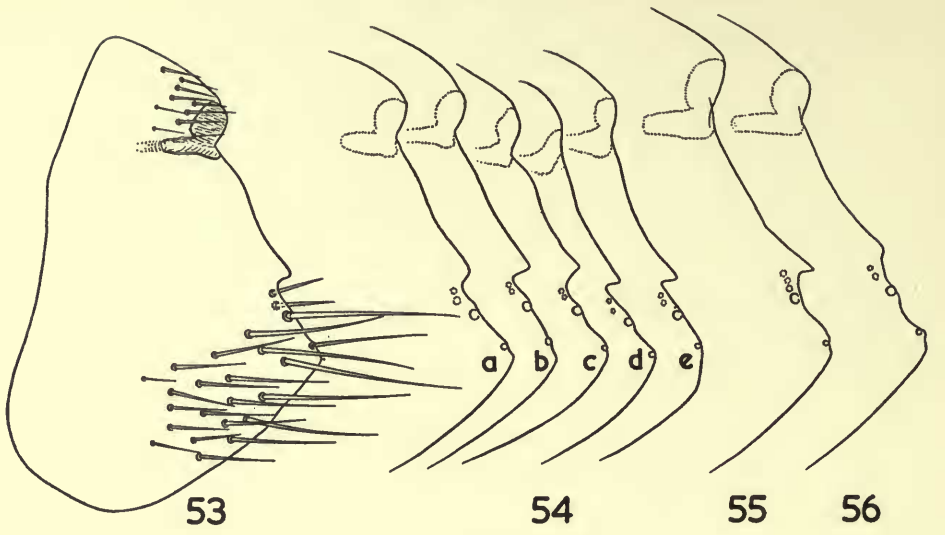
DIAGNOSIS. Separable from all other African members of the genus, except *S. sellatus*, by the possession of dorsal ctenidia on some of the abdominal terga; from *S. sellatus* in the male by the possession of (a) a large area of thin setae on the inner side of the movable process, (b) only one acetabular seta (there are two such setae in all other African species), (c) a number of shortish spiniform setae on the ventro-apical margin of sternum IX, (d) sickle-shaped dorso-apical aedeagal sclerite; in the female by the presence of large, curved and rather narrow sclerites associated with the bursa copulatrix.

DESCRIPTION. HEAD. As in *S. torvus*.

THORAX. Pronotal ctenidium with 24-27 (normally 24) slender spines in the male, 25-26 in the female. Metanotum with a main row of seven setae on each side. In other respects the thorax, as well as the legs, resemble those of *S. torvus*.

ABDOMEN. All the marginal spinelets developed into spines, which form conspicuous dorsal ctenidia on terga II-IV (Text-fig. 27) and sometimes also on V; on tergum I there are usually no spines (occasionally one, or one on each side), on tergum II four or five on each side, on tergum III four (sometimes five), on tergum IV three or four in the male and two to four (generally three) in the female, and on tergum V one (sometimes two) in the male and one or none in the female. Basal abdominal sternum with a lateral patch of one to eight (average four) small setae in the male and 12-20 (average 17) in the female. Otherwise the unmodified abdominal segments are like those in *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 15, 23). Tergum VIII with three to six smallish setae each side anterior to the vertical portion



of the spiracular fossa. Sternum VIII with 25–30 setae each side, the three most apical of the ventral setae are set closely together. Apodeme of tergum IX and manubrium (Text-fig. 15) more or less as in *S. torvus*. Fixed process of clasper with one long acetabular seta only. Movable process of clasper like that of *S. torvus*, but relatively longer, the down-bent apical portion forming an angle far greater than a right angle with the basal portion (contrast *S. sellatus*, Text-fig. 14). Sternum IX (Text-fig. 15) not unlike that of *S. torvus*, but the apical part of the distal arm is little widened, proportionally longer and the spiniform setae along the ventro-apical margin are much blunter and more widely spaced. Aedeagus as in Text-fig. 23; dorso-apical aedeagal sclerite sickle-shaped; tendons of phallosome making about two convolutions; dorsal margin of aedeagal apodeme strongly concave preapically.

FEMALE (Text-figs. 37, 50–52). Sternum VII (Text-figs. 50, 51) of the shape usual for the *torvus*-group and with a chaetotaxy resembling that of the other species in this group. Tergum VIII with a row of five setae in front of the vertical portion of the spiracular fossa; chaetotaxy of the ventral part of this tergum as in other species of the group; posterior margin of tergum VIII as in Text-fig. 52. Anal segment more or less as in *S. torvus*. Bulga of spermatheca thick-walled, with only a small dorsal hump, hilla with a papilla (Text-fig. 37). The pair of dark sclerites associated with the bursa copulatrix long and slender and markedly curved; the dilated part of the ductus spermathecae is long, not very wide, and internally provided with the usual membranous rings (Text-fig. 37).

LENGTH. ♂ 3–3½ mm., ♀ 3½–4¼ mm.

REMARKS. I have pleasure in naming this new flea, a parasite of the arboreal *Rattus* (*Praomys*) *morio*, after Dr. P. L. Pirlot, who made extensive collections of fleas while studying and collecting mammals in the Belgian Congo.

Stivalius cacuminis sp. n.

(Text-figs. 12, 24)

TYPE MATERIAL. Male holotype collected on the top of Mt. Soque (about 40–50 miles east of Lobito), Angola, from a mouse,¹ on 27.viii.1954, by G. Heinrich. The holotype is in the Chicago Natural History Museum.

¹ Dr. R. L. Wenzel, of the Chicago Natural History Museum, kindly informed me that the following rodents were collected by Mr. Heinrich on Mt. Soque on August 27, 1954: *Graphiurus* sp., *Otomys irroratus*, *Dendromus* sp., *Lophuromys sikapusi*, *Oenomys* sp., *Pelomys fallax* and *Rattus* (*Praomys*) *namaquensis*. Since *Stivalius cacuminis* is closely related to *S. pirloti* (a parasite of *Rattus* (*Praomys*) *morio*) it is possible that *Rattus* (*Praomys*) *namaquensis* is the true host of *S. cacuminis*.

FIGS. 53, 54. *Stivalius torvus* (Rothschild). 53. Tergum VIII of female (Keruguya, Kenya). 54. Outlines of tergum VIII of females (*a-c*: Keruguya, Kenya, *d-e*: Machakos, Kenya). Figs. 55–62. Outlines of tergum VIII of females of: 55. *S. vancanneyti* Berteaux (holotype). 56. *S. afer* (Rothschild) (holotype). 57. *S. parilis* sp. n. (*a*—paratype, *b*—allotype). 58. *S. timanus* Jordan (*a*—allotype, *b*—paratype). 59. *S. nigeriensis* Jordan (*a*—holotype, *b*—Adiopodoumé, Ivory Coast). 60. *S. sellatus* Jordan & Rothschild (holotype). 61. *S. richardi* Jordan (allotype). 62. *S. curtiductus* sp. n. (holotype). Figs. 63–65. Pronotum of females of: 63. *S. aestivalis* Jameson & Sakaguti (Hanase, Kyoto Prefecture, Honshu, Japan). 64. *S. ferinus* (Rothschild) (Namunukula, Ceylon). 65. *S. insolli* Traub (Brinchong Hill, Cameron Highlands, Malaya).

DIAGNOSIS. On the structure of the aedeagus this new species is nearest related to *S. pirloti*, from which it can be distinguished at once by the absence of ctenidia on the anterior abdominal terga.

DESCRIPTION. Head, thorax, legs and unmodified abdominal segments as in *S. torvus*.

MODIFIED ABDOMINAL SEGMENTS AND GENITALIA. MALE (Text-figs. 12, 24). Segment VIII as in *S. torvus*, except for the apical subventral group of setae on sternum VIII which consists of only three setae with four very small setae opposite these, on the inner side of the sternum. Apodeme of tergum IX, manubrium and fixed process of clasper (Text-fig. 12) similar to those in *S. torvus*; movable process much longer than that of *S. torvus*, with a relatively narrow patch of thin setae subventrally on the inner side of the long straight portion; the ventral margin of the apical bent-down portion with four long setae (Text-fig. 12). Sternum IX (Text-fig. 12) resembling that of *S. pirloti*, differing in some small details. Aedeagus as in Text-fig. 24; the tendons of the phallosome make nearly two convolutions; dorso-apical aedeagal sclerite sickle-shaped; the dorsal margin of the aedeagal apodeme is strongly concave before the tip.

LENGTH. ♂ $3\frac{1}{2}$ mm.

KEY TO THE AFRICAN SPECIES OF *Stivalius*

1. Genal margin below eye divided into two partly overlapping lobes (Text-fig. 1);
♂—tendons of phallosome short, hardly reaching beyond apex of aedeagal apodeme (Text-fig. 16); dorsal margin of aedeagal apodeme almost straight (Text-fig. 16); ♀—no paired sclerotic structure alongside the bursa copulatrix (Text-fig. 25); dilated part of ductus spermathecae slender, with a number of thick sclerotic internal rings (Text-fig. 25) (*ferinus*-group) *alienus*, p. 42
- Genal margin below eye entire (Text-fig. 2); ♂—tendons of phallosome making at least half a convolution (Text-figs. 17, 18); dorsal margin of aedeagal apodeme strongly concave preapically (Text-figs. 17, 18); ♀—bursa copulatrix in most species with a dark sclerotic structure on each side (Text-fig. 26, 28–37); dilated part of ductus spermathecae with a large number of membranous internal divisional rings (Text-figs. 26, 28–37) (*torvus*-group) 2
2. Terga II–IV with developed dorsal ctenidia (Text-fig. 27) 3
- These terga with only one subdorsal marginal spinelet 4
3. ♂—Apical portion of movable process bent downwards at about a right angle; along the ventral margin before the bend a relatively sparse group of thin setae; fixed process of clasper with two acetabular setae (Text-fig. 14); ♀—Bursa copulatrix very small, the sclerites not much darkened (Text-fig. 36) *sellatus*, p. 69
- ♂—Down-bent apical portion of movable process forming an angle considerably greater than a right angle with the basal portion, the latter part bearing a large area of thin setae on inner side; fixed process with only one acetabular seta (Text-fig. 15); ♀—Bursa copulatrix fairly large, the curved sclerites very long and narrow (Text-fig. 37) *pirloti*, p. 71
4. Dorsal (posterior) margin of hind tibia with seven groups of setae in notches; pronotum dorsally much shorter than dorsal pronotal spines; pronotal ctenidium

- with 20 spines (male unknown) *nigeriensis*, p. 65
- Dorsal margin of hind tibia with eight groups of setae; normally at least 22 pronotal spines which are usually about as long as (or a little shorter than) pronotum 5
5. Males (this sex not known of *afer*, *curtiductus* and *vancanneyti*) 6
- Females (this sex not known of *fallaciosus* and *cacuminis*) 11
6. Tendons of phallosome making at most half a convolution; apex of aedeagal apodeme without a tendril (Text-fig. 17) 7
- These tendons making at least a whole convolution; apex of aedeagal apodeme drawn out into a fairly long and not strongly sclerotized tendril (Text-fig. 18) 8
7. Dorso-apical part of distal arm of sternum IX drawn out into a long and sharply pointed projection (Text-fig. 13); dorso-apical aedeagal sclerite very large (Text-fig. 21) *richardi*, p. 53
- Dorso-apical part of distal arm of sternum IX not forming a long and pointed projection (Text-fig. 8); dorso-apical aedeagal sclerite much smaller (Text-fig. 17) *torvus*, p. 47
8. Upper extension of dorso-apical aedeagal sclerite sickle-shaped (Text-fig. 24); ventral margin of basal part of movable process with a narrow group of thin setae (Text-fig. 12) *cacuminis*, p. 73
- Upper extension of dorso-apical aedeagal sclerite not sickle-shaped; area of thin setae along ventral margin of movable process much wider 9
9. Vento-marginal group of setae on movable process extending along curvature of margin to the first large ventral seta of down-bent portion; apex of widened part of distal arm of sternum IX splayed out (Text-fig. 11) *fallaciosus*, p. 67
- The group of thin setae on movable process not extending along curvature of margin; apex of widened part of distal arm of sternum IX not splayed out 10
10. Proximal arm of sternum IX subequal in length to distal arm; dorso-apical angle of club-shaped expansion of latter arm broadly rounded (Text-fig. 10); ventro-apical angle of lower lateral aedeagal lobe of about 90°; dorsal wall of aedeagal inner tube relatively thin (Text-fig. 18) *timanus*, p. 63
- Proximal arm of sternum IX distinctly longer than distal arm; apex of latter arm not much widened (Text-fig. 9); apical and ventral margins of lower lateral aedeagal lobe forming a very acute angle; dorsal wall of inner tube very thick (Text-fig. 19) *parilis*, p. 61
11. Dilated part of ductus spermathecae short and thick, not or hardly longer than spermatheca (Text-fig. 26, 28–30) 12
- Dilated part of ductus spermathecae relatively long and narrow (Text-figs. 31–37) 14
12. Only a vestige left of the sclerites associated with the bursa copulatrix; undilated part of ductus spermathecae very short (Text-fig. 29) *curtiductus*, p. 55
- Sclerites associated with bursa copulatrix well developed; undilated part of ductus spermathecae much longer (Text-figs. 26, 28, 30) 13
13. Sclerites of bursa copulatrix fairly small and roughly triangular (Text-figs. 26, 28) *torvus*, p. 47
- These sclerites very large and shaped like the sole of a shoe (Text-fig. 30) *richardi*, p. 53
14. Sclerites about as long as bursa copulatrix (Text-figs. 33, 34) 15
- Sclerites about twice as long as bursa copulatrix (Text-figs. 31, 32) 16
15. Sclerites and bursa copulatrix relatively large, nearly as long as bulga of spermatheca (Text-fig. 33) *parilis*, p. 61
- Sclerite and bursa copulatrix much smaller in relation to length of bulga (Text-fig. 34) *timanus*, p. 63
16. Dilated part of ductus spermathecae about seven times as long as wide (Text-fig. 31) *vancanneyti*, p. 57
- Dilated part of ductus spermathecae about twelve times as long as wide (Text-fig. 32) *afer*, p. 59

ACKNOWLEDGMENTS

I am deeply indebted to the following colleagues for the loan or gift of specimens of African species of *Stivalius* : Dr. V. Aellen (donation of a female of *S. nigeriensis*), Dr. P. L. G. Benoit (loan and donation of much material from the Musée Royal du Congo Belge), Dr. R. Devignat (donation of specimens of *S. alienus*), Prof. Dr. F. Peus (donation of holotype of *S. fallaciosus*) and Lt.Col. R. Traub (donation of a male *S. sellatus* and permission to describe this sex, and for inviting me to describe a male from Angola (*S. cacuminis*) which he had found among material sent to him by the Chicago Natural History Museum).

